SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JANUARY 1925.

GENERAL PHYSICS.

1. *Elastic After-working and Hysteresis.* **K. Bennewitz.** (Phys. Zeits. 25. pp. 417–431, Sept. 1, 1924.)—Taking the effect of a force varying with time according to the law G(t), acting upon an ideal "after-working" substance as given by $\beta' \int \frac{G(t)dt}{t_a - t + \tau}$ at time t_a, the elastic properties of the substance are found to depend upon two constants, β' and $\gamma = -\log_{10} \tau$. The effects of V and sine wave form for G are worked out in detail, and formulæ connecting β and γ with measurable quantities are thus obtained. In particular, it is found that the ratio of the energy lost per cycle in a vibrating elastic body, due to hysteresis, is a definite fraction of the average value of the energy, and that γ can be found from this ratio, which can itself be found from the log. dec. of the vibration. From this and from ordinary elastic measurements, including those of elastic hysteresis, two distinct determinations of each of the constants β and γ are made, which agree to within 2½ %. W. G. B.

2. *An Optical Interference Method of Measuring Young's Modulus for Rods.* **G. F. C. Searle.** (Cambridge Phil. Soc., Proc. 22. pp. 475–480, Sept., 1924.)—Describes a simple apparatus for determining Young's Modulus of a mild steel rod. The rod is fixed vertically and has a load applied to the upper end by means of a horizontal bar projecting out, from the end of which a weight is suspended. Two plates are soldered on the rod at different levels; one plate carries a plane glass plate and the other a plane convex lens. Interference fringes are produced between the glass plate and the lens. E. G.

3. *Compressibility and Molecular Weight of Methyl Ether.* **T. Batuecas.** (Comptes Rendus, 179. pp. 565–567, Sept. 22, 1924.)—Describes the method used and the results obtained in a new determination of the compressibility of methyl ether. It is found that the compressibility decreases with the pressure. The molecular weight is deduced to be 46·044, which gives for carbon 11·999. J. W. T. W.

4. *The Applicability and Deformability of Surfaces.* **B. M. Sen.** (Cambridge Phil. Soc., Proc. 22. pp. 243–247, Sept. 20, 1924.)—Beltrami

showed that corresponding to any ruled surface there is another applicable to it, but which is not mutually deformable into it. This paper, which is entirely mathematical, develops equations by which every surface applicable on a given surface must be defined, and shows that corresponding to each solution is another applicable but not mutually deformable. Beltrami's case is one in which the solution is easy, but in general the solution is impracticable. A. Wh.

5. *Viscosity of Glass.* **H. le Chatelier.** (Comptes Rendus, 179. pp. 517–521, Sept. 15, 1924.)—Ignoring such specimens of glass as became devitrified during the experiments, the results of E. Washburn and G. Shelton may be expressed accurately by the formula $\text{Log}\log\eta = -Mt + P$ where η is the coefficient of viscosity, t the temperature, and M and P are constants for a particular glass, the discrepancies being well within the limits of experimental error. Apparent discrepancy between the results of these and previous experimenters in the neighbourhood of 500° C. can be explained on the basis of the recent discovery that glasses occur in two allotropic forms, α and β, the change generally taking place between 500° and 600° C. G. A. S.

6. *Allotropy of Glass.* **H. le Chatelier.** (Comptes Rendus, 179. pp. 718–721, Oct. 20, 1924.)—The results of recent experiments of S. English are shown to fit the author's explanation [see preceding Abstract] of certain anomalies in previous results for the viscosity of glass at different temperatures. The law of variation of viscosity with temperature is shown to undergo a sudden change at a temperature which differs for different varieties of glass, indicating a change in the nature of the glass at this temperature. G. A. S.

7. *On the Plane Vertical Motion of Continuous Viscous Liquids.* **J. Grialou.** (Comptes Rendus, 179. pp. 748–750, Oct. 20, 1924.)—The differential equations for the notion are first established and Bernoulli's equation deduced therefrom, in which the integral of the second member represents the frictional effect. It is shown that even for viscous liquids the vortex character is constant along the same trajectory. H. H. Ho.

8. *Plasticity and Strength of Rock-Salt Under Water.* **W. Ewald** and **M. Polányi.** (Zeits. f. Physik, 28. 1. pp. 29–50, 1924.)—The results of measurements of the plastic bending of strips of rock-salt immersed in water, supported at the ends and weighted in the middle, indicate that the effect is due to a lowering of the elastic limit which occurs immediately on contact with water and ceases on drying or on saturation of the water with salt. The same effect is observed, although not quite so pronounced, when only the upper face of the bent prism is wetted, but the plasticity is scarcely observable if only the lower face is wetted. From the above observations the conclusion is drawn that, at ordinary temperatures, the essential part of the resistance is situate in the surface, and that during the solution of the surface layers this resistance is removed. There appears to be slip along the rhombic dodecahedron faces, fine steps or slip lines being formed; in the normal surface these slipping layers fit into one another.

The increased strength of rock-salt under water observed by Joffé, Kirpitcheva, and Levitzky [Abstract 1994 (1924)] has also been investigated, as much as tenfold increase in strength being observed. Prisms of the salt, from which the surfaces have been removed by dissolution, exhibit normal tensile and bending strength. If, however, the surface is dissolved while the salt is loaded, the strength after drying may be as much as five times the normal value. If the salt prism is broken so that only the under-side is under water, the upper part of the crystal being covered with a water-tight coating, fracture occurs at normal load. Evidently the elastic limit of rock-salt is lowered under water. T. H. P.

9. *Physical Research in the Cotton Industry.* **A. E. Oxley.** (Manchester Phil. Soc., Mem. 68. pp. 69–80, 1923–1924.)—Physical and mechanical tests are specially adapted for determining important properties of cotton yarn during the (1) spinning, (2) weaving, (3) finishing processes. Regularity of twist hardness in single yarns is recorded photographically by drawing the yarns between a pair of case-hardened steel shoes, the upper one being movable vertically, and magnifying, mechanically and optically, the motion of the top shoe. A periodicity of twist-hardness, due to the intermittent mechanism of the mule, is observed. In another test, the thread is subjected to repeated variations of tensile stress until rupture ensues, and the bearing of such a test on the operation of weaving is discussed. Comparative lustre is determined in a suitably designed photometer, and also photographically recorded by exposure under graduated illumination, fading off uniformly from one side to the other of the field. Photographic and diagrammatic illustrations of the special apparatus employed are given, together with graphs typical of results obtained. A. B. C. L.

10. *Slip Bands in Stressed Solid Bodies.* **A. Nádai.** (Zeits. techn. Physik, 5. 9. pp. 369–378, 1924. From the Internat. Congress for Angewandte Mechanik, Delft, 1924.)—The experiments recorded were undertaken with a view to corroborating the assumptions on which the theory of fracture, as enunciated by de St. Vennant, rests. The method adopted was the observation of the slip bands or Lüders lines produced on the polished surfaces of stressed test pieces. Compression, tension, torsion and punching tests were made, and the straight-line or logarithmic-spiral systems of slip lines produced are analysed and compared with the distribution of shear stress derived from theoretical considerations. Numerous photographs of actual test pieces are given. The materials used included paraffin-wax, marble, zinc, copper and iron. In the last case, the slip system was developed by suitable etching reagents. J. V. H.

11. *Trajectories of Small Horizontal Velocity in a Resisting Medium.* **J. E. Littlewood.** (Cambridge Phil. Soc., Proc. 22. pp. 217–233, Sept. 20, 1924.)—This paper has been published because the results which were developed some years ago may now have scientific utility in view of a recent paper by Richardson [see Abstract 2109 (1923)]. It is concerned with trajectories of a particle under gravity in a medium, in the first instance homogeneous, which produces a retardation μV^2 when the velocity is V. By suitable assumptions, the problems become soluble by approximation, in terms of functions requiring only tables of single entry. The formulæ are arranged to give the elements x, t, u, v of the trajectory for a given y, the form most likely to be required in practice. The downward motion is reckoned from the vertex as origin, and the latter being a singularity of the motion, all the arguments are a little more subtle than would be expected. A final section is devoted to the problem of variable atmospheric density, which is a fruitful source of fallacy, and is discussed for some other ballistic questions, to which the answers are sometimes unexpected. The paper is mathematical throughout. H. H. Ho.

12. *Photographic Study of the Fall of Spheres into Liquids.* **G. E. Bell.** (Phil. Mag. 48. pp. 753–764, Nov., 1924.)—Smooth steel balls are allowed to fall with a velocity in all cases of about 300 cm. per sec. into different liquids and the course of the disturbance followed with a view of testing the theory given by Mallock and deciding how far the surface tension, a factor not considered in the theory, affects the form of the cavity in the liquid. The balls are either clean or coated with water, paraffin-wax, paraffin oil, and turpentine, while the liquids into which the falls took place included these and solutions of glycerine of varying viscosity. It is found that Mallock's theory gives results not far from the truth, but the disturbing influence of surface tension can be seen, and for very viscous liquids quite different effects seem to result. On the photographs appear certain horizontal striæ which the author is unable definitely to explain. A. Wh.

13. *A Visual Method of Measuring Short Time Intervals.* **H. G. Dorsey.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 351–352, Sept., 1924.)—The operation of this machine is based on the principle of persistence of vision enabling one to read the position of a flash of light in a Geissler tube wherever it may occur while in rapid rotation. A disc carries a small Geissler tube back of a narrow radial slot. Slip-rings and brushes make connection with the tube, and the disc is rotated by a motor. Concentric with the disc is a graduated circular scale, and the flash of light being practically instantaneous gives a readable indication at almost any speed of rotation. More than one flash may be read during a single revolution, and with slight practice the positions of three flashes may be easily read to half-divisions on a scale 20 cm. in diameter divided into 100 parts. This gives a method of measuring the time interval between the start and finish of one or two events occurring at unexpected times. Reference is made to the application of the machine in connection with measuring ocean depths by the "echo" method. E. G.

14. *The Quadratic Form for Radial Acceleration.* **R. Hargreaves.** (Cambridge Phil. Soc., Proc. 22. pp. 248–252, Sept., 1924.)—In a previous paper the transformation corresponding to constant acceleration and the quadratic form derived from it, there is an arbitrary constant [Abstract 2563 (1924)]. A transformation is here applied which elucidates the meaning of this constant. The paper is entirely mathematical, careful inquiry being made into the assumptions underlying the treatment of the equations. The law of attraction consequent on these investigations gives the central attraction due to a point as varying according to $r^2/(ar^3 + b)^{4/3}$. A. Wh.

15. *Vibrations of Bars.* **E. F. Relf** and **W. L. Cowley.** (Phil. Mag. 48. pp. 646–653, Oct., 1924.)—The work here described was undertaken to throw light on questions relating to the practical problem of vibration in aeroplane wing spars. Certain spars have been found to give marked vibration troubles through resonance with the engine or with aerodynamic forces over a wide range of frequency. For the sake of simplicity, investigation was confined to the case of a uniform thin beam symmetrically supported at three points. The spars used in aeroplane construction differ from this simple beam in two ways: (*a*) they are usually tapered, and (*b*) their depth is so great that the rotatory inertia of the beam elements might have an appreciable effect. These differences do not affect the general arguments of the present paper, but only their direct application to particular cases in practice.

The experiments were conducted on a brass rod 0·126 in. diameter and 5·09 ft. long. The vibrations were also treated theoretically by the usual differential equations. The comparison between theory and experiments is then exhibited in a series of tables, and the agreement is found to be excellent. E. H. B.

16. *Equations of Motion of a System of Particles of Variable Mass.* **R. Dugas.** (Comptes Rendus, 179. pp. 673–676, Oct. 13, 1924.)—Entirely mathematical. A. Wh.

17. *Vibration of Pump Valves.* **W. Hort.** (Zeits. techn. Physik, 5. 9. pp. 384–387, 1924.)—In certain circumstances vibration is produced in flat bodies set in a fluid stream at right angles to their plane. This is illustrated in the case of spring-loaded pump valves and in the so-called oscillation syrens. The fundamental principles of mechanics and hydrodynamics suffice for a theoretical mathematical treatment of the problem, and lead to the establishment of characteristic equations involving area of surface, natural frequency, damping, and stream velocity. S. L. S.

18. *On the Order of a Non-Holonomous System.* **P. Appell.** (Comptes Rendus, 179. pp. 549–550, Sept. 22, 1924.)—A material system is considered having k degrees of freedom whose most general virtual displacement compatible with the conditions at the time t is obtained by giving to k parameters $q_1, \ldots q_k$, infinitesimal arbitrary increments $\delta q_1, \ldots \delta q_k$. If, according to Hertz's nomenclature, the system is holonomous, the parameters may be chosen such that the Lagrangian equations apply to the k parameters. If the system is not holonomous it is useful to introduce a positive integer which, for a choice of parameters, defines the order of the non-holonomous system. This order is for the choice $q_1, \ldots q_k$, the number of these parameters to which the Lagrangian equations are not applicable. If T be the velocity and S the acceleration energies respectively of the system, $T = \frac{1}{2}\Sigma m V^2$, $S = \frac{1}{2}\Sigma m J^2$, the order is the number of differences

$$\Delta_\nu = \left[\frac{d}{dt}\left(\frac{\partial T}{\partial q_\nu'} - \frac{\partial T}{\partial q_\nu}\right)\right] - \frac{\partial S}{\partial q_\nu''} \text{ where } (\nu = 1, 2, \ldots k)$$

which are not zero. This order may change with the choice of parameters, but there exists an essential order which is the smallest value assumed when the choice of parameters is made to vary arbitrarily. If this order be zero for a system, the latter is holonomous, *e.g.* the hoop is a material system with 3 degrees of freedom but of essential order 2. H. H. Ho.

19. *Diffusion in Mixed Crystals.* **H. Braune.** (Zeits. phys. Chem. 110. pp. 147–165, 1924.)—Information concerning the magnitude of selfdiffusion coefficients may be obtained by means of observations on velocities of diffusion in systems of mixed crystals with components so similar that reciprocal chemical action is excluded. Especially suitable in this respect are the metals of the copper group, which exhibit extensive and sometimes complete miscibility in the solid state. An expression is deduced by means of which it is possible, from the observed value of the coefficient of diffusion, to calculate the proportion of the atoms which change place with neighbouring atoms per unit time.

The experimental method used was that formerly employed by Roberts-Austen. The results obtained with a rod composed, as to part of its length, of pure silver and, for the rest, of a silver-gold mixture containing 10 % of gold, give for the diffusion constant of gold into silver at 1073° a value about fifty times less than that observed by Roberts-Austen; the experimental values at 1189°, 1120°, and 1040° abs. agree well with those calculated from the equation, $\log_e D = 3 \cdot 65 - \frac{13{,}370}{T}$.

The results of experiments made with cylinders of silver, of silver containing 10, 20, 40, 60, 80, 90 % of gold, and pure gold, each in contact with a cylinder of silver containing 2 % of copper, furnish no indication of a pronounced mobility of the copper into the mixtures with medium concentrations of gold. Further, the diffusion of copper into silver proceeds appreciably more readily than that of the heavier gold [see Gróh and Hevesy, Abstract No. 1665 (1921)].

Just below the melting-point the silver atom makes, on the average, 50,000 vibrations before it changes its place, such change occurring 10^8 times per sec.; at the room temperature the atom changes its position only once a year, and at about 200° (500° abs.) once in 0·1 sec.

T. H. P.

20. *Studies on the Deformation of Tungsten Single Crystals under Tensile Stress.* **Research Staff of the General Electric Co., London.** (Phil. Mag. 48. pp. 800–819, Nov., 1924.)—A combined X-ray and microscopic study is made of the deformed single crystals—in particular the fractured crystals—which are produced by the extension and fracture of fine tungsten wires composed of crystals, many of which occupy locally the complete volume of the wire. The deformation may be accounted for in all cases by slip on the (112) planes and in the [111] direction, with the single exception of a crystal subject to special constraints which slipped as well on the (100) planes and in the [100] direction. The [111] direction represents the line of densest packing of atoms for this type of lattice structure—the body-centred—the [100] direction being next in order. The results are therefore in accord with the direction of easiest slip in the case of single crystals of metals involving other types of lattice. Marked distortions of the crystal planes occur in the direction of slip equivalent to changes in inclination of the plane to this direction of from 10°–20° without any corresponding change in the atomic spacing, which leads to the view that such distorted crystals are no longer "single crystals" in the strict sense, and that such distortion is the cause of hardening due to slip. The most favourable crystal orientation for extension by slip is such that two sets of 112 planes are symmetrical to the stress, each making an angle of 35° with the direction of stress, in agreement with the most prevalent orientation in drawn tungsten wires and rolled tungsten foils. The most favourable orientation for slip on one set of planes is about

40° to the direction of stress, which accounts for the stability of crystal orientation when two sets of (112) planes are symmetrical to the stress.
AUTHOR.

21. *On the Crystal Structure of Cuprite and Rutile.* **G. Greenwood.** (Phil. Mag. 48. pp. 654–663, Oct., 1924.)—The measurements were made by the ionisation method, using K_α rhodium rays, $\lambda = 0 \cdot 615$ Å., and special attention was paid to the measurements of reflexion intensities. A comparatively wide slit was used, and a series of readings was made over a range which included the peak. The crystal was swept with uniform angular velocity through the reflecting angle corresponding to the chamber setting, and a flat-topped peak was obtained. For cuprite $d_{100} = 2 \cdot 142$ Å., and the volume d_{100}^3 contains one-quarter of a molecule; this is in agreement with the structure previously found. In addition, the small first order reflexion from the (110) planes, which had been overlooked, has been found. The structure factors are given by the equations $A_{100} = 58 + 8 \cos n\pi$, $A_{111} = 58 + 8 \cos (n\pi/2)$, $A_{110} = 37 + 29 \cos n\pi$, where n is the order of the spectrum. Theoretically the measured intensities might be expected to vary as the square of the structure factor, and this is true of simple structures such as rock-salt. In calcite and aragonite they vary more nearly as the first power of the factor. For cuprite the values of I/A and of I/A^2, plotted against the corresponding angle, fit about equally well on a smooth curve. This may be due to the fact that all the factors concerned have very nearly their maximum value. The results obtained with rutile leave no doubt as to the correctness of Vegard's work. No trace was found of the two reflexions described by Williams; $d_{100} = 2 \cdot 29$ Å., in satisfactory agreement with Vegard's $2 \cdot 26$ Å. Vegard's values for glancing angles were afterwards employed throughout. A quarter molecule is contained in the cell $d_{100}^2 \times d_{001}$, and this suggests a centred prism structure. The results are of a similar order to those of Vegard, and figures are given illustrating this structure. The structure factors are given by $A_{100} = 22 + 16 \cos n\alpha$, $A_{110} = 30 + 8 \cos n\alpha$, $A_{101} = 22 + 16 \cos (n\alpha/2)$, $A_{111} = \frac{1}{2}[22 + 16 \cos n\alpha + 38 \cos n\pi]$; $\alpha = 216°$; the parameter ϵ, which fixes the position of the O atoms is $0 \cdot 300$. Assuming the diameter of the O atom $2 \cdot 58$ Å., and that of the titanium atom $1 \cdot 32$ Å., the structure can be fitted together so as to get contacts between the different spherical atoms. The question as to the relation between the intensity and the structure factor for rutile is also of interest, and is considered in detail.
H. N. A.

22. *Crystalline Structure of Lead and Thallium.* **G. R. Levi.** (N. Cimento, 1. pp. 137–144, May–June, 1924.)—Lead has a cubical structure; thallium a close-packed hexagonal.
A. D.

23. *The Crystalline Reticuli of the Rhombohedric Carbonates of Bivalent Metals.* **G. R. Levi** and **A. Ferrari.** (Accad. Lincei, Atti, 33. i. pp. 516–521, June 15, 1924.)—Following on a previous note, the present paper deals with measurements carried out on magnesite, smithsonite, calcite and dolomite. The experimental results, set forth in tables and treated mathematically, are found to be in close agreement with those calculated from the reticular constants.
E. F.

24. *Crystal Structure and Absorption Spectra.* **R. Hill** and **O. R. Howell.** (Phil. Mag. 48. pp. 833–847, Nov., 1924.)—Reviews the theories proposed to account for the changes of the colour of cobaltous compounds. Hantzsch and Shibata in 1912 concluded that the blue solutions examined by them contained complexes, in which the cobalt atom is associated with four groups, and the red solutions complexes in which the cobalt atom is associated with six groups. The authors, working without knowledge of the above paper, and starting from the observation that the absorption spectra of cobalt spinel, cobalt blue and the blue solution of cobalt oxide in potash are very similar, have in the present paper examined the absorption spectra of a number of cobaltous solutions and of pigments derived from divalent cobalt. They conclude that the blue colour is due to the direct association of the cobalt atom with four atoms or groups, and the red colour to direct association with six. Their idea of the nature of the associations is entirely different from that of H. and S., and is applicable generally. The latter hypothesis can hardly be used to account for the colour of the pigments, while the authors' idea of the association in solution is founded on the structure of coloured crystals. Curves are given showing the fraction of the light absorbed for different wave-lengths, with a number of specially prepared pigments and solutions of various compounds. In general the forms of these curves are very similar for all the blue compounds, though in some cases there are distortions, while the red compounds also show similar curves, but with the absorption maximum at the high-frequency end of the spectrum. In all cases the colour observed agrees with the authors' theory. H. N. A.

25. *Tabulated Data for the Examination of the* 230 *Space-Groups by Homogeneous X-Rays.* **W. T. Astbury** and **Kathleen Yardley.** (Roy. Soc., Phil. Trans. 224. pp. 221–257, Aug. 20, 1924.)—The object of the present paper is to express the conclusions of mathematical crystallography in a form which shall be immediately useful to workers using homogeneous X-rays for the analysis of crystal structures. The results are directly applicable to such methods as the Bragg ionisation, powder, and rotating crystal processes, and summarise in as compact a form as possible what inferences may be made from the experimental observations, whichever one of the 230 possible space-groups may happen to be under examination. It is only in certain cases that the spacings of crystal planes, as determined by the aid of homogeneous X-rays, agree with the values of those spacings which would be expected from ordinary crystallographic calculations. In the majority of cases the relative arrangement of the molecular in the unit cell leads to apparent anomalies in the experimental results, the observed spacings of certain planes or sets of planes being sub-multiples of the calculated spacings. Cases of this apparent anomaly are discussed, and Bragg's method quoted for discriminating between the various space-groups of the monoclinic system. In the present paper this method has been extended to the whole of the 230 space-groups possible to crystalline structures. In general, it may be said that if a crystal possesses a certain glide-plane, a certain set of planes lying in the zone whose axis is perpendicular to that glide-plane will have their periodicity reduced by one-half. It is now shown that, given a crystal belonging to a particular system and class, the X-ray worker can, with two exceptions, determine to which space-group the crystal belongs by means of the number of molecules per unit cell and the abnormal spacings found. To facilitate this work, diagrams are given, one for each of the 230 space-groups, showing the distribution of symmetry elements and the relative positions and orientations of the molecules in the unit cell; and accompanying these diagrams are tables giving the fundamental Bravais lattice, the number of asymmetric molecules per cell, the abnormal spacings to be expected, and the possible molecular symmetry for each space-group. The general introduction gives an account of the usefulness of such tabulated data, and explains the abbreviated notation used in the tables and the symbols adopted in the diagrams. To each system there is a special introduction, describing the Bravais lattices on which the space-groups in that system are based, and giving any information which concerns only that particular system and which may be of use in applying the data given to any special case. Under certain circumstances X-ray methods alone can also reveal the class to which a crystal belongs, and such particulars are given as will enable the worker to decide when and how this may be done. In general, however, X-ray examination alone fails to determine the class of the crystal, and the limitations of the method are clearly indicated in the paper. A few examples are given of some of the crystals the structures of which have already been determined, these being referred to their particular space-groups. Twenty plates are included. H. H. Ho.

26. *Strengthening and Recrystallisation.* **R. Gross.** (Zeits. f. Metallkunde, 16. pp. 344–352, Sept., 1924.)—The lecturer attempts to refer deformations of a crystal to a system based on the slip planes T formed in the crystal, the direction of slip t, and an axis f, perpendicular to t, about which the lattice can be bent. In gypsum there is only one definite f direction, and the conditions are very simple. If a gypsum-crystal is split parallel to (010) into thin plates, and bent about the axis [101], cylinders can be obtained with a radius of curvature of less than 1 cm. without any cracks; if the direction is not followed exactly the cylinder consists of a number of different pieces, each of which is bent round [101], and meeting one another in broken edges. X-rays may be used to confirm this large-scale experiment. In metals there are several f directions, and the lecturer has investigated tungsten wires (single crystals), which were bent in several different directions, and examined by the Laue method, so as to find the position of the axis f. Experiments on the bending of rock-salt rods, as depending on load, time of loading, and sectional area of the rod are described, which confirm the lecturer's previous assumption of a strengthening through the action of slip planes. The effect of the crystal surface on the strength of the rods is investigated, and it was found that the bending strength depends on the inner constitution of the crystal, not on the surfaces. The recovery of crystals after distortion was studied, partly by examination of etched surfaces and partly by means of Laue diagrams. In rock-salt it was found that the distorted substance recrystallised with suitable heat treatment. H. N. A.

27. *Theoretical Calculation of the Brownian Movement from the Gas Standpoint.* **F. Zeilinger.** (Ann. d. Physik, 75. 4. pp. 403–425, Oct., 1924.)—Part I of this paper commences with a discussion of the work of Einstein [see Abstract 1909 (1905)], Perrin, Haas-Lorentz, and Smoluchowski. Following this the translatory and rotatory motions are calculated for the cases of elastic and diffuse reflections, condensation and re-evaporation, agreement being attained with the Epstein results. In Part II the mean square of the translatory and rotatory velocity changes is calculated for all three cases, and, by the aid of the Fokker-Planck hypothesis and the mobilities, the average squares of the velocity and displacement are derived from which in all cases the Einstein formula proceeds. The paper is entirely mathematical. H. H. Ho.

28. *Quantum Defect and Atomic Number.* **L. A. Turner.** (Phil. Mag. 48. pp. 384–395, Sept., and pp. 1010–1014, Nov., 1924.)—In continuation of previous investigations [see Abstract 417 (1924)] the author notes that if ν be the value of a spectroscopic term, the quantity defined by the equation $\nu = R/x^2$, where R is the Rydberg constant, is called the effective quantum number, by analogy with Bohr's theory of the H atom. If n be the total quantum number of the electron orbit corresponding to the term, the difference $n - x = q$ is defined as the quantum defect. In the first of the papers here considered it is shown that the asymptotic value of this quantum defect, which it approaches for the former term values of a series of terms, is a linear function of the atomic number for corresponding series of elements of the same chemical sub-group, provided that the quantum numbers assigned by Bohr be increased for elements of high atomic number. An approximate relationship of the same sort holds for the quantum defects computed from the largest terms of the series, since these do not differ greatly from the asymptotic value and the deviation is usually in the same direction. These largest term values are the ones, however, which are proportional to the ionising potentials of the elements considered. The value of x, the effective quantum number for the largest term, can be computed from the relation $V_i = 13 \cdot 53/x^2$, V_i being the ionising potential, and 13·53 being the value of the Rydberg constant expressed in volts, *i.e.* the ionising potential of the H atom; and it is shown in the second paper that there is a linear relation between the atomic number and the quantum defects computed from ionising potentials of the rare gases, from the second ionising potentials of the rare gases, and from the ionising potentials of the H halide molecules. Also the following critical potentials are predicted on the basis of these relations: Ionising potential of Nt, of atomic number 86, 27·5 ± 1·5 volts; appearance of a "blue" spectrum of Ne, 45·2 ± 1·2 volts; ionising potential of HF, 17·9 ± 0·5 volts. G. W. de T.

29. *Weak Quantisation.* **P. Ehrenfest** and **R. C. Tolman.** (Phys. Rev. 24. 287–295, Sept., 1924.)—The authors call the quantisation *weak* in cases where a motion allowed by the equation $\int p\,dq = nh$ has an *à priori* weight less than the normal value h, and *strong* where the quantised motion has the full normal *à priori* probability. Since it is usual, if not always possible, to arrive at a given condition of weak quantisation by an adiabatic transformation from a suitably chosen condition of strong quantisation, it may be expected that the decrease below the normal value in the *à priori* probability of a weakly quantised motion is taken over either by neighbouring classically allowable motions, or by neighbouring strongly quantised motions, when such are present in the region of the phase space considered. Weak quantisation is to be expected when uncertainties arise as to the period that should be used in determining the limits of the phase integral $\int p\,dq$. Several cases are considered: (1) When the period is so long that there is considerable chance of interruption by a quantum transition; (2) when a system has two apparent periods, a long, true period T and a short quasi-period θ; (3) when the periodicity is disturbed frequently in a fortuitous manner as by molecular collisions. In (2) the tendency towards quantisation with respect to T may be gradually replaced by quantisation with respect to θ as T is lengthened, and then the probability of quantum transitions which correspond to quantisation with respect to T is weakened, while that of transitions related to θ is strengthened. This suggests the possibility that the strengthening of the probability of transitions related to a period θ may be accompanied by a strengthening of quantisation with respect to that period. G. W. DE T.

30. *Resonance Mechanism of Quantum Emission.* **L. de Broglie.** (Comptes Rendus, 179. pp. 676–677, Oct. 13, 1924.)—The view of quantum phenomena previously developed [Abstract 2200 (1924)] is applied to the case of an electron passing to an orbit of rank n from an orbit of rank $n + p$, where n is great and p is small compared with n. If ν be the characteristic frequency of any orbit, the orbit n is defined by a group of waves of which one has a frequency ν_{n+p}. Hence the orbit $n + p$ is a possible one. The movement of an electron on the orbit n may be represented by the superposition of waves of frequencies ν_n and ν_{n+p} in resonance of the nth and $n + p$th orders respectively. At p points on the orbit will there be equivalent phase, and at one of these the electron will be situated. A. Wh.

31. *The Bohr Atom.* **R. A. Millikan** and **I. S. Bowen.** (Phys. Rev. 24. pp. 223–228, Sept., 1924.)—The extension of the laws for X-ray doublets to ultra-violet spectra has given values of the screening constant in agreement with the Moseley-Bohr formula. This extension means a considerable simplification, but it implies the identification of the L_I, L_{II}, L_{III} X-ray levels with the s, p_2, p_1 terms of optical series respectively. This would make p_2p_1 correspond to 2_12_2 orbits (whereas they are always both assigned to 2_2 orbits), and would also assign both s and p_2 to the 2_2 orbits. In this case the screening constant must, contrary to the natural assumption, be much more affected by orientation of orbit (inner quantum number) than by the shape of the orbit (azimuthal number). This seems to require either (1) discarding the relativity explanation of p_2p_1 and L_{II} L_{III} doublets and with it all relativity effects in electronic orbits, or (2) introducing a dissymmetry not heretofore contemplated in atomic models, abandoning Bohr's interpenetration ideas and his assignment of azimuthal quantum numbers. A. D.

32. *Atomic Force Fields.* **F. S. Brackett.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 237–249, Sept., 1924. Paper read before the Am. Phys. Soc., Cincinnati, Dec., 1923.)—In a previous paper Brackett and Birge have shown the regularities in the development of the "quantum defect" in passing from one atom to another of higher atomic number but similar structure [Abstract 1385 (1924)]. In the present paper attention is mainly devoted to the circular orbits, and they are used to study the force fields within the atom body. Neglecting at first the fact that the change of energy, when an electron is carried to infinity from a given orbit, which is known from spectroscopic data, may be due to changes in the energy of other parts of the atom, in addition to the energy change in the electron, the "apparent force" and "apparent radius" are calculated. The former is due to an apparent charge Zae on the nucleus, where Za is roughly the difference between the atomic number and the average number of electrons inside the orbit; the energy $W = -RhZa^2/n^2$ and $h\nu = -W$, or $\nu = RZa^2/n^2$, where ν is the frequency corresponding to the series head. Calling $\sqrt{R/\nu}$ the "denominator," D, $Za = n/D$. The values of Za for the virtual orbits can thus be obtained directly from the curves of the previous article; the apparent radius of the orbit $a_a = n\mathrm{D}a_0$, where a_0 is the radius of the 1_1 orbit of hydrogen. $1/Za$ is plotted against a_a/a_0; in general four points are known for each atom from the 1_1, 2_2, 3_3 and 4_4 circular orbits; near the nucleus $Za = \mathrm{Z}$ and outside the atom body $Za = 1$; the curves become asymptotic to $1/Za = 1$ for great distances from the nucleus. In the case of the alkali metals the points within the atom body lie in straight lines, which intersect the vertical axis in the points $1/Za = 1/\mathrm{Z}$. The elements O, Mg, S, Ca show linearity in a much more limited region. The slopes of the linear segments show a regular progression from element to element. When the reciprocal of the slope is plotted against the atomic number the points lie on well-defined straight lines, with discontinuities where, according to Bohr, the formation of a circular orbit group takes place. The slopes have values practically in the ratio 3 : 2 : 1. In an analytical discussion the author deduces that the total screening γ can be divided into an inner and outer "screening" effect; this makes possible a determination of the charge distribution in the saturated conditions. The outer "screening" effect is apparently due to the energy changes in the atom body when the electron under consideration is removed to infinity. H. N. A.

33. *The Fine Structure of Mercury Lines and the Isotopes.* **H. Nagaoka, Y. Sugiura** and **T. Mishima.** (Japanese Journ. Phys. 2. Nos. 6–10. pp. 121–162, 1923. In English.)—Contains a full account of the research, the results of which have been published [see Abstract 1807 (1924)]. Crossed spectra were employed in analysing the lines of mercury and quartz. Lummer-Gehrcke plates were used for a number of lines in the ultra-violet which could not be analysed with plates or echelon gratings of glass. In consequence of the great increase in the dispersion of quartz with decreased wave-length the fine structure of the ultra-violet lines can easily be studied. The mathematics of the distribution of intensity round the interference points in crossed spectra is worked out, and diagrams are given showing this distribution in a number of different cases. A number of plates show photographs of crossed spectra for the different lines examined, and figures are given showing the positions and estimated intensities of their satellites. Assuming that in the case of mercury one of the nuclear protons is not rigidly bound to the rest of the nucleus, but is quasi-elastically connected with it, it is deduced that the difference between the wave-lengths emitted by different isotopes, with atomic weights A_i and A_j, will be $\delta\lambda = \lambda(1/m_i - 1/m_j)/2$, where m_i and m_j are equal to $\mathrm{A}_i - 1$ and $\mathrm{A}_j - 1$ respectively, being the masses of the rigid portions of the nuclei. Taking the six isotopes of mercury it is shown that $\mathrm{A}_j - \mathrm{A}_i$ will have all the whole number values from 1 to 7, so that there will be seven groups of values for $\delta\lambda$; for several lines all seven groups are represented, while for others only a few have been found; in many cases the difference between the calculated and observed values of $\delta\lambda$ is small. λ3131·84 does not conform to the above rule, the differences in wave-length being too small. An explanation is suggested for this anomaly, based on the hypothesis that the law of electric action is modified at distances comparable with nuclear dimensions, so that there is attraction between like charges and repulsion between unlike. Thus the electrons of the nucleus may be bound together into one mass and the protons into another, the two masses being connected quasi-elastically so that they can make coupled vibrations. This seems to be the case when the above line is excited. For other interesting points in the investigation the original paper should be consulted.

H. N. A.

34. *Spectroscopic Evidence of Isotopy.* **H. Nagaoka** and **Y. Sugiura.** (Japanese Journ. Phys. 2. Nos. 6–10. pp. 167–278, 1923. In English.)—It is generally supposed that the isotopes of the same element cannot be distinguished spectroscopically, as the electron configurations are the same and the nucleus charges are identical. Reference is made to the investigation of the fine structure of the lines of mercury made by the authors in conjunction with T. Mishima [see preceding Abstract]. Here it was assumed that a nucleus consists of a central mass, with a detached proton, the coupled vibrations of the system giving rise to satellites due to the different isotopes. Similar relations have been observed for bismuth. The case is analogous to the vibration of the H and Cl atoms in HCl. Somewhat similar relations must hold from time to time in the case of atomic encounters, even in a monotomic gas. Neglecting the rotational and higher terms, an expression is found for the wave number ν of the emitted light, by means of which the value of $\Delta\lambda$ can be calculated, on certain assumptions, when the mass of the nucleus is altered. This alteration = 1, 2, 3, 4 . . . for different isotopes, and $\Delta\lambda$ generally amounts to many ångströms for the known elements, exceeding one hundred ångströms for the light elements. The infra-red spectrum of mercury was first examined from this point of view, and good agreement was found with the observed lines of McLennan and Shaver. Matters are simpler with elements which have only two isotopes, and a remarkable number of lines in good accord with the formulæ obtained were found in the cases of neon, chlorine, argon, copper and zinc. Tables of different pairs, giving the wave-length differences, are included for the above elements and for Li, Si, Br and Rb. It is possible to determine the existence of unknown isotopes from spectroscopic data; apparently barium may have the isotopes 135, 137 and 138, with 139 doubtful. Certain spectra, with constant frequency differences, are ascribed to the rotational term. The nuclear distances during the encounter are calculated for Ne, A and Cu, and are in harmony with the dimensions of electronic orbits. H. N. A.

35. *Mass-Ratio of Isotopes.* **F. M. Jaeger** and **D. W. Dijkstra.** (K. Akad. Amsterdam, Proc. 27. 5–6. pp. 393–406, 1924.)—The observed atomic weights of the chemical elements must depend upon the special ratio of the isotopes in the mixture. If this ratio is variable, then the atomic weight will no longer be a constant. So far no variability has been observed within the limits of experimental error. It may be so, because all matter has been so mixed up in its formation that all local differences have been effaced; consequently any sample of an element virtually has come from the same store. Or it may be that there is some intrinsic cause inherent in the nature of the atomic structure which makes one isotope more probable than another, and that this probability is constant. A third explanation is that the elements are all radio-active residues; in this case a difference might be expected in the atomic weight, according to the previous history of the sample. To investigate this the authors have found the specific weights of tetra-ethyl-silicane, using silicon from six widespread terrestrial sources and six meteorites which fell at wide intervals of time.

The pycnometer was of the Ostwald-Sprengel type, slightly modified, and used in a thermostat kept constant to 0°·001 C. while the pycnometer was immersed. All weighings were made on a micro-balance. Precautions were taken to prevent temperature and electrical disturbances. The weighings are regarded as certain to a hundredth of a milligramme.

The values obtained did not differ by more than 0·006 %. Small deviations were obtained; these are at present attributed to small traces of by-products in the preparation of the compound, for an examination of the refractive indices of the samples showed a rough parallelism between density and refractive-index change.

The authors conclude that their results uphold the second theory.

A. C. M.

36. *Alteration of Mass when Protons are Closely Packed.* **W. A. Plotnikow.** (Zeits. f. Physik, 28. 6. pp. 339–341, 1924.)—It is sometimes assumed that atomic nuclei, the atomic weights of which follow the formula 4*n*, are built up of α-particles, while others contain α-particles and 1, 2 or 3 protons. This, however, is not necessarily the case, and the protons may not really be bound together in groups similar to the helium nucleus. On the second assumption, in the case of the radio-active elements, it happens from time to time that four protons in the nucleus reach a configuration which favours their union to form a helium nucleus, and the energy thus released is so large that the atom disintegrates. Owing to this inter-atomic catastrophe, the stable configurations of the other parts of the nucleus are disturbed, and so the first products of disintegration are unstable, and they disintegrate. One gramme atom of radium gives $6 \cdot 4 \times 10^{11}$ gramme calories on disintegration. When a helium atom is formed from protons and electrons the loss of mass is 0·0298 in hydrogen units. From this the heat of formation of a gramme atom of helium is found to be $6 \cdot 4 \times 10^{11}$ gramme calories, which is the same as the heat of disintegration given above. It is suggested that the other α-particles, given off in the disintegration from radium to lead, are present as such in the radium, and are simply removed from their stable configurations by the first internuclear catastrophe. Thus the loss of mass, when radium changes into helium and lead, should be very minute, and as a matter of fact the difference between the atomic weights of Ra and Pb is almost exactly twenty. The difference between the atomic weights of uranium and radium is greater than 4*n*, where *n* is a whole number, and it may be assumed that the α-particles given out do not exist, as such, in uranium, and that the protons unite to form α-particles, with evolution of heat, when disintegration takes place. The fact that Rutherford and Chadwick were able to drive out protons from sulphur, and not from oxygen, agrees with this view. The atomic weight of oxygen is 16, and the nucleus contains four α-particles; that of sulphur is 32·07, and there are protons in the nucleus which are not concentrated to form a helium nucleus.

H. N. A.

37. *Molecular Diameters from Surface-Tension Measurements.* **S. Mokroushin.** (Phil. Mag. 48. pp. 765–768, Nov., 1924.)—Molecular dimensions can be determined by (1) kinetic or dynamic, or (2) statistical methods. Surface-tension methods allow the determination of the molecular diameter of a liquid or gas, and is independent of the determination of the mean free path resulting from collisions. From the equation of van der Waals and the Avogadro number the molecular diameter can be calculated, since 6/7 of the term b appears to be the volume actually occupied by the molecules.

By utilising the Clapeyron equation, and assuming that the internal heat of vaporisation is used in increasing the surface energy in the process of change of state—that is, increasing the free surface of the molecules—an expression is obtained for the diameter of the molecule

$$d = \sqrt{4 \cdot 189 \times 10^7/\pi N} \, . \, \sqrt{Q - RT}/\sigma$$

where N is the Avogadro number and σ the surface tension.

Since $\sqrt{4 \cdot 189 \times 10^7/\pi N}$ is a constant $= 4 \cdot 41 \times 10^{-9}$, the equation becomes

$$d = K\sqrt{Q - RT}/\sigma$$

Molecular diameters calculated from this equation for N_2, H_2O_2, H_2O, Cl_2, Br_2, are given and compared with values obtained by different methods. F. J. B.

38. *The Distribution of Electrons among Atomic Levels.* **E. C. Stoner.** (Phil. Mag. 48. pp. 719–736, Oct., 1924.)—The scheme for the distribution of electrons among the completed sub-levels in atoms proposed by Bohr [see Abstract 1941 (1922)] is based on somewhat arbitrary arguments as to symmetry requirements; it is also incomplete in that all the sub-levels known to exist are not separately considered. The subject is discussed under the following heads: (*a*) Classification and number of X-ray levels; (*b*) suggested distribution of electrons; (*c*) comparison with Bohr's distribution; (*d*) significance of inner quantum numbers; (*e*) statistical weight of electrons bound in atoms; (*f*) evidence as to electron distribution. A distribution of electrons in the atom is proposed, according to which the number in a sub-group is simply related to the inner quantum number characterising it. A formal justification of the connection is given. The suggested numbers of electrons in the sub-levels of the completed K, L, M . . . groups are (2), (2, 2, 4), (2, 2, 4, 4, 6) . . . respectively. The scheme enables all the essential features involved in Bohr's picture of atom-building to be retained, and so is equally in accord with general chemical and spectroscopic evidence, but it differs in the distribution in the completed groups and in indicating a somewhat simpler mode of development. Evidence based on considerations of intensities of X-ray lines, absorption of X-rays, chemical and magnetic properties, and optical spectra is discussed and shown to give considerable support to a distribution of the kind put forward. A. E. G.

39. *Relativity.* **F. Severi.** (Accad. Lincei, Atti, 33. i. pp. 429–435, May 30, 1924.)—Deduces the Lorentzian transformations from a new set of postulates, founded on the psycho-rhythmical sense of time. A. D.

40. *Walden Inversion.* **B. K. Singh.** (Sci. Assoc. Maharajah's Coll. Vizianagaram, J. 2. No. 1. pp. 1–11, 1924. In English.)—A statement of the Walden Inversion is made and a summary given of experimental investigations relating to it. The various explanations put forward to explain the effect by Armstrong, Gadamar, E. Fischer, Werner and Debye are examined, and their inadequacy to explain all of the experimental facts shown. The further failure of the theories is shown when dealing with the change of sign of rotatory power of an optically active compound in different solvents. R. S. R.

41. *Ambiguity in the Relativity Theory.* **G. v. Gleich.** (Zeits. f. Physik, 28. 6. pp. 329–334, 1924.)—This paper contains an account of the most important results from a previous memoir on the relativity perihelion disturbance (Astron. Nachr. 222. 49., 1924) which are of interest to the physicist [see also Abstract 2445 (1924)]. The general theory of relativity supplies in general no definite value of a perihelion displacement, but only the arbitrary fixation of certain parameters which enter into the formulæ. These may be so inserted without invalidating the basis of the theory that the perihelion may even stand still or have a retrograde motion. Mohorovicic's work is briefly referred to. H. H. Ho.

42. *Determination of the Curvature of Space-time.* **K. Lundmark.** (Roy. Astron. Soc., M.N. 84. pp. 747–770, Oct., 1924.)—An exhaustive examination and criticism of Silberstein's determination of this quantity [Abstracts 1694 and 2203 (1924)]. The author shows that if a greater number of data are considered the regularity in Silberstein's results disappears. A large number of measurements are critically analysed in order to see whether any reliable estimate of the curvature of space-time can be made, but the conclusion is in the negative. The globular clusters show no significant correlation between V and r, while the supposed crowding of stars about the neutral sphere round the sun is non-existent if all the 30 stars having a parallax greater than $0''\cdot 20$ be considered instead of the 19 employed by Silberstein. The following classes of bodies are also examined for such a measurable regularity: Cepheids, Novæ, O Stars, Eclipsing Variables, R Stars, N Stars, and the Spiral Nebulæ. A. Wh.

METEOROLOGY AND GEO-PHYSICS.

43. *Dust in the Atmosphere.* **J. J. Nolan.** (Nature, 114. pp. 720–721, Nov. 15, 1924.)—A review of the Ninth Report of the Committee for the investigation of atmospheric pollution. E. G.

44. *The Supposed Periodic Variations of Pressure over Large Land Areas.* **J. C. K. Rav.** (Sci. Assoc. Maharajah's Coll. Vizianagaram, J. 1. No. 4. pp. 114–120, 1924. In English.)—The pressure of India, taken as the mean of that at Calcutta, Bombay and Madras, and covering the period 1855-1920, has been analysed and the amplitudes for periods from one to thirteen years have been computed. It is found that amplitudes of the same order would be obtained from a fortuitous distribution of pressure; consequently there appears to be no definite evidence showing periodicity in the variations of Indian pressure. A. W. L.

45. *Radiogoniometric Researches on the Movement of Cyclones.* **E. Gherzi.** (Onde Élec. 3. pp. 491–501, Oct., 1924.)—This paper contains the result of observations made from June to October, 1923, at the observatory of Chang-Hai for the object of ascertaining the connection between the movement of cyclones and atmospherics. The author, having proved the correctness of the conclusions of Rothé [see Abstract 1064 (1923)] on the subject of continental depressions and summer storms, he has tried to apply the same method to cyclonic centres of typhoons. In a previous paper the author has proved a very marked diminution of atmospheric discharges during the approach of cyclonic centres. Full tabular details of the present observations are given. A. E. G.

46. *The Great Japanese Earthquake of September* 1, 1923. **K. Suda.** (Imp. Marine Obs. Kobe, Japan, 1. pp. 139–239, Aug., 1924.)—The records of the Japanese observatories show that the epicentre was situated around the centre of the Sagami Bay and that the depth of the focus was about 48 km. From the isochronic curves relations are obtained between the velocity of the longitudinal wave and distance from the epicentre, and between the angle of emergence and distance from the epicentre. The initial motion was nearly always perpendicular to the isochronic lines. Charts of the isosiesmals, or lines of approximately equal shock, show a very irregular distribution, which is discussed in relation to geological and topographical effects.

Large landslips were caused in many parts, and the maximum upheaval in the epicentral region amounted to 7·6 m.; the upheaved land began to subside after about three days. The earthquake was also accompanied by changes in the temperature and rate of discharge of local hot springs, some of these occurring before the main shock.

The Kobe records show that 152 after-shocks were experienced in the following sixty days. The after-shocks are divided into two groups, according to the location of their epicentres: (1) The Bōsō group, which generally gave strong, dull shocks; (2) the Sagami-Sakawa group, which generally gave weak, rapid shocks. Possibly the former might have been caused by horizontal sliding and the latter by subsidence of the earth's crust. The relationships shown between the frequency of the after-shocks and time, and also between the frequency and local meteorological conditions, are investigated.

One of the principal causes of the earthquake may have been the strain occurring between two adjacent areas suffering different displacements. A rough calculation of the potential energy which might have been stored up in the neighbourhood of the earthquake gives $2·764 \times 10^{23}$ ergs.

A. W. L.

47. *Some Problems relating to Antarctic Sea-Ice.* **R. W. James.** (Manchester Phil. Soc., Mem. 68. 7. pp. 81–90, 1923–1924.)—The paper is founded on observations made during the drift of Sir E. Shackleton's *Endurance* in the Weddell Sea, 1915–1916. The general features of the ice drift are stated from the drift of several ships during last century and the present one. The controlling factor in the drift is the wind produced by a radial outflow of air from the great continental ice-cap. The general formation of ice floes is considered and the production of pressure ridges on the floes. The salinity of the ice forming the floes is dealt with and a theory given for the gradual sinking in the ice of inclusions of saline solution.

R. S. R.

48. *Possible Cause of Microseismic Disturbances.* **J. Lacoste.** (Comptes Rendus, 179. pp. 568–570, Sept. 22, 1924.)—The author has compared the records of the microseismic disturbances at Strasbourg with (*a*) the records of atmospheric pressure, and (*b*) those of wind velocity. He finds that if the mean monthly amplitude of the disturbances be plotted, and the resulting curve be compared with that obtained by plotting the mean monthly variation of barometric pressure, ΔH, a noticeable similarity of shape in the two curves is found. If the mean variability of the wind velocity ΔV be also calculated, the curve obtained by plotting the values of $\Delta H \times \Delta V$ for each month shows a still closer resemblance to the microseismic curve.

J. W. T. W.

ASTRO-PHYSICS.

49. *The Radiative Equilibrium of a Rotating System of Gaseous Masses.* **H. v. Zeipel.** (Roy. Astron. Soc., M.N. 84. pp. 665–683, Oct., 1924.)—The general theory of the radiative equilibrium of a system of gaseous masses in rotation is given on the lines of Schwarzschild, Eddington and Milne. The fundamental assumption is that the nature of the gas does not vary along a level surface. The absorption coefficient is taken as a function of the product pT^{-4}, and the gas is supposed to obey van der Waal's equation. Eddington has shown that the perfect gas law is applicable to stars, but the more general case is taken to make the theory applicable to bodies such as planets. An expression for the relation between the density and the gravitational potential is obtained and the features of general solutions briefly discussed. It appears that the solution is only possible for bodies which are nearly spherical. A. Wh.

50. *The Radiative Equilibrium of a Slightly Oblate Rotating Star.* **H. v. Zeipel.** (Roy. Astron. Soc., M.N. 84. pp. 684–701, Oct., 1924.)—Starting from the relation deduced in another paper [see preceding Abstract] the case where the system consists of a single body of slight oblateness is worked out. Use is made of spherical harmonics, and the unknowns are expanded in terms of the oblateness. Relations are deduced between mean density, angular velocity and oblateness, and the variation of gravity, surface brightness, and effective temperature with latitude. Numerical workings are given for perfectly gaseous stars. A. Wh.

51. *The Radiative Equilibrium of a Double-Star System.* **H. v. Zeipel.** (Roy. Astron. Soc., M.N. 84. pp. 702–719, Oct., 1924.)—The methods developed in two previous papers [see preceding Abstracts] are applied to the case of a double-star system where the components are spherical and with a circular orbit and are small in comparison with their distance apart. The solution is obtained by the expansion of the unknowns in powers of the ratios of these radii to the distance separating the components. If certain terms are omitted it is possible to reduce the problem to the case of each body considered separately, the other component being reduced to a point. The forms and brightness distributions on the two components are studied. A. Wh.

52. *New Variable Star in Gemini.* **A. S. Williams.** (Roy. Astron. Soc., M.N. 84. pp. 744–746, Oct., 1924.)—Variability of star in R.A. 7h. 47·9m. and Dec. + 32° 50′ (1855), first noted in 1921 November, since observed visually with a 6½-inch reflector. Forty-seven observations are used, and the author finds a period of 8·875 days; magnitude at maximum 10·04, and at minimum 10·24, so that the range is only the fifth of a magnitude. The variable is probably a Cepheid, but since the decrease in brightness is nearly as quick as the increase, the minimum may lie actually midway between two maxima. A light curve is given. The author urges that photometric observations should be undertaken.

A. S. D. M.

53. *O-Type Stars.* **F. J. M. Stratton.** (Observatory, 47. pp. 297–299, Oct., 1924.)—A summary of J. S. Plaskett's work on O-type stars in the Publications of the Dominion Astrophysical Observatory, ii. p. 287, 1924. The points are: Whereas the spectra run in the sequence, O–B–A, both the radial velocities and the bright lines follow the sequence at the other end of the series, M–O–P (which seems to indicate that there may be something in a star's birth which gives it an initial high velocity); the masses of the O-type stars average about 50 times the sun's mass, the range for individual stars being from 10 to 80; the average absolute magnitude is taken as $-4\cdot0$ and the mean parallax as $0''\cdot0011$; the high-velocities of O-type stars make it possible to distinguish the H- and K-line velocities from the stellar [see Abstract 813 (1924)]; the emission O-type stars (Wolf-Rayet) have broad bright bands to be generally identified with the lines of absorption O-type stars, but it would seem that the emission and absorption levels of a Wolf-Rayet star must be different; and the emission O-type stars are brighter than the planetary nuclei, which are again brighter than the absorption O-type stars. A. S. D. M.

54. *Effect of Electrical State on the Pressure Relations in a Gaseous Star.* **S. Rosseland.** (Roy. Astron. Soc., M.N. 84. pp. 720–728, Oct., 1924.)—The ideal gas laws assume the forces between the molecules of the gas to be small compared to those which would exist if the molecules were ions. It is interesting to obtain an estimate of the effect this deviation from the ideal gas conditions will have on the theory of stellar constitution. The ionisation is given by Boltzmann's principle, and use is made of Debye and Hückel's theory of the potential energy of a mixture of ions. The conclusion is reached that the electrical component of the pressure will be quite unimportant compared with the gas pressure so long as the molecular mass of the gas is low. It is pointed out that the treatment is only an approximation. A. Wh.

55. *Absolute Magnitudes of Stars in the Pleiades.* **H. Kienle** and **P. ten Bruggencate.** (Zeits. f. Physik, 28. 6. pp. 373–392, 1924.)—The colour-magnitude diagrams for five star-clusters published by ten Bruggencate showed that this method offers a new and simple way of attacking various problems relating to stellar evolution [Abstract 2230 (1924)]. A similar diagram has been drawn up for the stars of the Pleiades, based on the catalogues of Trumpler and Shapley. When the relation between colour-index and absolute magnitude (deduced from the parallax of $0''\cdot006$ adopted for the group) is compared with the relation between colour, spectral type, and absolute magnitude which exists in the general system of the stars, according to the Mt. Wilson results, it is found that the brightness is much less than it should be in the case of the fainter Pleiades stars, and slightly less in the brighter Pleiades stars. It is shown that the most probable explanation of this anomaly is that the fainter stars suffer from strong absorption by the nebulosity known to exist in the Pleiades. It is further suggested that the relative ages of clusters may be deduced from their colour-magnitude diagrams, since the youngest should contain a large number of red giants; those further advanced would have a majority of blue stars, and in later stages dwarfs would predominate, the maximum of colour again tending towards red. It appears that the Pleiades are in an earlier stage than was supposed, the majority of its stars being near that turning-point in evolution where giants cannot be sharply separated from dwarfs. It is probably to be placed between M37 (chiefly giants) and M67 (exclusively dwarfs). M. A. E.

56. *Faint Stars of Appreciable Proper Motion.* **H. L. Alden** and **P. van de Kamp.** (Astron. J. 35. pp. 165–166, May 20, 1924.)—A table of 38 stars between 7·4 and 12·0 magnitudes, whose proper motion is equal to or greater than ten seconds of arc per century. Probably all the stars are dwarfs, and the spectral types which are known are F5 or "later." The authors group the stars according to size of proper motion into four classes, and conclude that if the 1905 stars measured are representative of the whole sky, at least 2 % of the stars, between the magnitudes 8 and 11, have total proper motions in excess of $0''\cdot 10$ per year. A. S. D. M.

57. *Observations of Asteroids.* **G. H. Peters.** (Astron. J. 35. pp. 149–153, May 8, 1924.)—181 photographic observations of asteroids made with the 10-inch photographic equatorial of the U.S. Naval Observatory, between dates 1919, January 4, and 1923, September 17. One asteroid is certainly new, and is given the number (980) and the name *Anacostia.* All have been identified except one, which is provisionally designated as (1921 W18). A. S. D. M.

58. *Naked-eye Observations of Venus.* **H. H. Turner.** (Roy. Astron. Soc., M.N. 84. pp. 770–772, Oct., 1924.)—The record of several observers' observations on the days on which Venus could first be seen in the evening, last be seen in the evening, and first be seen in the morning. Further observations of this kind are desirable in connection with the interpretation of ancient records. A. Wh.

59. *Lunar Eclipse of 14 August, 1924: Observations made at Lyons Observatory.* **J. Guillaume** and **(Miss) Bloch.** (Comptes Rendus, 179. pp. 751–752, Oct. 20, 1924.)—The weather was favourable. Within the shadow the colour was the usual red copper, passing from light to dark, so that in the central part it was a smoke-grey, with the lunar details barely distinguishable. Observations of disappearance at occultation were made of stars, B.D. − 15°·6047; 6046; 6050; 6052; and of reappearance of B.D. −15°·6037; 6042; 6041; 6044; 6046; 6047 and 6052. A. S. D. M.

60. *Polarisation of Light from Jupiter.* **B. Lyot.** (Comptes Rendus, 179. pp. 671–673, Oct. 13, 1924.)—The polarisation of the light from Jupiter is studied as the polarisation from Mercury, Mars and the Moon has been previously [Abstract 2220 (1924)]. In this case a different condition of the planet is indicated. In general the polarisation is much less than in the other cases, but there appears abnormally high polarisation from the polar caps of Jupiter. The observations indicate the presence of a dense, cloudy atmosphere, which, over the polar caps, is full of similarly oriented crystals like those which form halos. A. Wh.

61. *Occultation of B.D. −15°·6169 by Mars.* **S. D. Tscherny.** (Roy. Astron. Soc., M.N. 84. pp. 772–774, Oct., 1924.)—Measurements made at the Observatory, Kiew, on June 21, 1924. Corrections to Newcomb's and le Verrier's tables of Mars are given. A. Wh.

62. *Changes observed on Mars.* **E. M. Antoniadi.** (Comptes Rendus, 179. pp. 668–671, Oct. 13, 1924.)—A record of certain changes in form and colour of some of the darker markings on Mars as seen with the 83-cm. refractor of the Meudon Observatory. The changes extend in some cases over distances of several thousand kilometres, while changes of shade from green to brown and from pure brown to "lilac-brown" are noted. A. Wh.

63. *Retarded Diminution of the Circumpolar Snows of Mars.* **E. M. Antoniadi.** (Comptes Rendus, 179. pp. 557–559, Sept. 22, 1924.)—The author has studied the size of the circumpolar snows of Mars from all the data available, and has arrived at the average throughout the year for the period since 1856. A comparison of the areas observed this year with the mean value over the period since 1860 shows that the snows were much more extensive than normal from the beginning of June until the end of August, but resumed their normal size from the beginning of September. A similar retardation of the snow disappearance took place in 1913, and the author considers that these retardations are due to minima in the solar radiation. J. W. T. W.

64. *Remarkable Planetary Nebula in Cassiopeia.* **J. H. Reynolds.** (Observatory, 47. pp. 293–295, Oct., 1924.)—A large planetary nebula (N.G.C. 7635), in R.A. 23h. 17m. and Dec. $+ 60° 45'$, near open cluster M52 (N.G.C. 7654), is approximately elliptical, of diameters $2' 40'' \times 2' 15''$, and has one segment very bright, the other larger segment dark, but encircled by a faint ring. An 8th magnitude star (B.D. 60°·2522, 8·7 photo-visual magnitude) is eccentrically placed in the planetary and is just involved in the bright nebulosity, of which faint nodules are directed to the star; there is also marked evidence of absorption by dark nebulosity. The spectrum of this star is intermediate between the normal Wolf-Rayet type and the Oe5, and justifies the association of the nebula and star, but the latter may not be within the gaseous shell, though it probably is the source of the illumination effect. Centrally placed in the planetary is a faint 17th magnitude star, which probably gave origin to the nebula through an outburst. Such central stars in planetaries are brighter photographically than visually, and whilst comparatively faint in the visual spectrum, attain great brilliancy in the ultra-violet, probably surpassing normal O-type stars in temperature. The distance of the planetary is probably not less than 20 parsecs, in which case the dimensions of the gaseous globe must be 150 times the orbit of Neptune. For suggestions as to the mechanism which keeps such enormous bubbles of gas in existence [see Abstract 798 (1924)]. A. S. D. M.

65. *Elements of Minor Planet Alger* $N = 1924$ *QL.* **B. Jekhowsky.** (Comptes Rendus, 179. pp. 750–751, Oct. 20, 1924.)—The elements are derived from observations on February 5, 25, March 16 and May 3, by the discoverer of the minor planet at the Algiers Observatory, and the differences of the observed and calculated positions are tabulated. The magnitude at the moment of oppositions was 13·1. A. S. D. M.

66. *Light from Solidified Gases; Cosmic Phenomena.* **L. Vegard.** (Nature, 114. pp. 357–359, Sept. 6, 1924.)—The prominent green auroral line is to be regarded as the limiting case of the band N_2 from solid nitrogen, when emitted from solid nitrogen particles of molecular order of magnitude, which exist in free space. The characteristic lines of the auroral spectrum have been obtained from red to ultra-violet by means of slow kathode rays impinging on solid nitrogen diluted by inerts. Positive rays give both N_1 and N_2, but give otherwise a non-auroral spectrum; and rapid kathode rays give faint indications of the same non-auroral spectrum; in both cases there is a persistent afterglow of N_2. The solid nitrogen undergoes a change at 35°·5 abs., and above that temperature it emits a very faint and different spectrum, with no afterglow. Nitrogen is singular in this behaviour. [See Abstracts 2093 and 2776 (1924).] A. D.

67. *The Relative Sizes of the Kernels of Ten Electrons of Na, Mg, Al, and Si derived from the Homologous Spectra, and their Relation to the L X-Ray Levels of the Light Atoms.* **L. A. Turner.** (Astrophys. J. 60. pp. 81–86, Sept., 1924.)—The relative sizes of the kernels of ten electrons of Na, Mg, Al, and Si are computed from the Na I, Mg II, Al III, and Si IV spectra. Assuming 1 for Na, they are Mg, 0·740; Al, 0·575; Si, 0·472. These ratios indicate that the effective nuclear charge for the outer orbits of the kernel is equal to the true nuclear charge minus a screening constant, the same for all four atoms, and approximately the same as the screening constant derivable from the L X-ray levels of the light atoms. AUTHOR.

68. *The Periodoscope.* **H. de Miffonis.** (Astrophys. J. 60. pp. 133–139, Sept., 1924.)—The determination of a period from a set of isolated observations is a problem of frequent occurrence, particularly in astronomy. The author describes how this problem can be solved mechanically, and complete drawings of an instrument for this purpose are given. It is also shown how the principles involved can be used graphically without the instrument. AUTHOR.

69. *Distribution of Brightness on a Star Disc.* **M. Maggini.** (Accad. Lincei, Atti, 33. i. pp. 388–392, May 18, 1924.)—The distribution was determined by interferometer methods. For Uranus the coefficient of obscuration, from centre towards periphery, is about half that presented by the solar disc; for Vesta the distribution of brightness is almost exactly the same as that on the solar disc. A. D.

70. *On the Radiation and the Temperature of the External Photospheric Layers.* **J. Spijkerboer.** (K. Akad. Amsterdam, Proc. 27. 5–6. pp. 371–376, 1924.)—A recent paper by Lundblad on this subject [see Abstract 448 (1924)] contains conclusions of a decisive and far-reaching nature to which the present author raises serious objection, as also to the mode of treatment. The following points are discussed: (1) The differential equation from which Lundblad starts, this being for a plane layer, and the same as that of Schwarzschild. (2) The limiting conditions, which are put so that it is *à priori* assumed that if solely molecular scattering causes the change of intensity over the sun's disc, this distribution of intensity must be independent of the wave-length. Lundblad's conclusion that the influence of molecular scattering is very small thus rests entirely on an arbitrary supposition. (3) The insufficiency of the grounds advanced by Lundblad for the latter. As the further conclusions of Lundblad are based on the supposition that molecular scattering alone cannot be the cause of the distribution of intensity over the sun's disc, there is the same arbitrariness in these conclusions as in the supposition. (4) The question is treated as if the sun's atmosphere cannot consist of deeper layers, which absorb and scatter, and an outer layer which only scatters, so that neither the limiting condition referred to under (2) may be combined with the supposition of a flame layer under (1), nor the solution of the integral equations considered sufficient. When considering absorption alone or absorption with scattering within definite limits, Lundblad is held to draw conclusions which should be entirely eliminated.

H. H. Ho.

71. *Astronomy of the Jungfrau.* **F. W. Dyson.** (Observatory, 47. pp. 295–297, Oct., 1924.)—The observatory consists of a room with a balcony of about 5 yards square, facing south, of the hotel at Jungfraujoch, at an altitude of 11,500 feet. The instruments are mounted on solid little trolleys which can be pushed on to the balcony, and consist of a refractor of 24 cm. and focal length of 5 m. (the tube being reduced to about 1½ m. by means of two mirrors); and a Cassegrain reflector of 60 cm. and effective focal length of 15 m., both equatorially mounted, but without clockwork, all parts, optical and mechanical, being made by Schaer. The author considers that a successful permanent observatory (the observers living at a lower altitude and taking spells on the Jungfraujoch), with larger instruments, could do very useful astrophysical work, since the exposures at this altitude would be much shorter than at other European observatories. A. S. D. M.

72. *Dominion Astrophysical Observatory, Victoria, B.C.* **J. S. Plaskett.** (Observatory, 47. pp. 329–335, Nov., 1924.)—The site, about seven miles north of Victoria, is on an isolated eminence about 730 ft. high. The 72-in. mirror and the auxiliary 55-in. flat had their glass from the St. Gobain glass works at Paris, and were ground by John A. Brashear of Pittsburgh, the mounting and mechanical parts being by Warner and Swasey of Cleveland. The telescope tube is 31 ft. by 7⅓ ft. outer diameter, and weighs 15 tons. Its central section is a cylindrical steel casting, heavily ribbed on the inside. The upper skeleton section is built up of structural steel, a special feature being the diagonal tension rods in each rectangular compartment, screwed up each to a tension of 2000 lbs., so that the whole tube is under tension in every position. The telescope can be moved by motors north or south, east or west, at the rate of 45 degrees per minute. The 72-in. telescope is generally used in the Cassegrain form, but can be changed to the Newtonian by a device due to Swasey. The observatory building is of steel construction, circular, 66 ft. in external diameter and with vertical walls 32 ft. high. The mechanism is described by which the mirror (which with its cell weighs 6 tons) can be resilvered, as is necessary about three times each year. Most of the work is spectroscopic, and a description is given of the Cassegrain spectrograph. The Callendar Recorder, a very accurate electrical thermostatic device, is used to maintain the temperature constant to one-hundredth of a degree throughout the exposures. A. S. D. M.

73. *Solar Observations made at Lyons Observatory in First Quarter of 1924.* **J. Guillaume.** (Comptes Rendus, 179. pp. 753–754, Oct. 20, 1924.)—There were registered two southern and five northern spot groups, of total area 285 millionths, their mean latitudes being $-19°\cdot0$ and $+13°\cdot3$ respectively; there were thirty-five southern and forty-four northern groups of faculæ of about 34·1 thousandths. Tables are given of details of the spot groups, and of the distribution of the spots and faculæ in latitude, in the three months of the quarter. A. S. D. M.

LIGHT.

74. *Electrical Double Refraction in Gases.* **N. Lyon.** (Zeits. f. Physik, 28. 5. pp. 287–298, 1924.)—The theory of double refraction of gases is discussed, and the various molecular theories are reviewed. The Brace half-shadow compensator was simplified and improved and utilised for measuring the double refraction of carbon dioxide at pressures ranging from 10–50 atmospheres. The experimental results obtained over this range of pressure show that the electrical double refraction is, like the density, proportional to the pressure. F. J. B.

75. *Precision X-Ray Spectrometers.* **J. C. Hudson.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 259–301, Sept., 1924.)—The paper gives a clear account of the details of construction of the spectrometers of Siegbahn and Duane. E. G.

76. *A New Precision X-Ray Spectrometer.* **W. Soller.** (Phys. Rev. 24. pp. 158–167, Aug., 1924.)—The novelty of this instrument consists of the multiple-slit collimators employed. These are tubes, in which flat strips of lead are placed parallel to one another, and axially in the tube, so that radiation from the X-ray tube passes through the rectangular tubes so formed ; the beam is thus kept parallel, but is much more intense than if only one deep slit was used. The ratio of width to length of each of the rectangular tubes formed by the strips is $\frac{1}{166}$. The spectrometer is otherwise of the Bragg type. Radiation from the tube passes down the collimator, is reflected off the specimen, and then traverses the other tube into the ionisation-chamber. Consequently a larger surface of the specimen is irradiated, the beam is stronger, and a larger cross-section of the ionisation-chamber is used. A sheet of steel gave accurate values for the Mo . $K\alpha_1$ and $K\alpha_2$ peaks, and the expansion of the steel to 475° C. was easily followed. The change in atomic distance when steel was stretched beyond the elastic limit was measured. A. C. M.

77. *Correction of a Statement concerning Fused, Blast-Free Quartz.* **M. v. Schwarz.** (Phys. Zeits. 25. pp. 374–376, Aug. 1, 1924.)—Under various titles reports have recently been published in America that E. Berry and his co-workers of the General Electric Co. have succeeded, after ten years' research, in fusing quartz in an electric oven and thus securing blast-free pieces. The statements have been accepted by various journals throughout the world without criticism. The discovery, however, must correctly be attributed to Helberger of Munich, who accomplished it eleven years ago by constructing a special oven for the production of blast-free, tension-free quartz pieces for optical purposes. The details and results were published in the German Patent Specification " Method for the Fusion of Quartz " on December 10, 1913, Patent No. 310,134, Class 32A, Group 35. The full description of the oven is given therein. The paper gives illustrations of the quartz fusion oven as designed by Helberger and also reproductions of polished and unpolished quartz pieces produced by him. A brief note is appended on experimental details and the uses of the samples produced. S. G. B.

78. *The Transmission of Light through Quartz Glass.* **G. Joos.** (Phys. Zeits. 25. p. 376, Aug. 1, 1924.)—In accordance with the work of Pflüger [Abstract 1637 (1904)], a plate of ordinary fused quartz glass 2·81 mm. thick will not transmit light of wave-length below 2000 Å.U. and only 56 % of light of wave-length 2100 Å.U. Working with quartz glass produced by the Helberger process, the paper reproduces a record obtained by photographing the ultra-violet spark spectrum of copper, using Schumann plates. The records are given for photographs obtained under three conditions for purposes of comparison: (1) Without any absorbing medium; (2) through a crystalline quartz plate 6 mm. thick; (3) through a Helberger fused quartz plate 6 mm. thick. It is noted that the absorption begins much lower than a wave-length of 2100 Å.U., and that even at $\lambda = 1980$ Å.U. the absorption is extremely small. In view of the difficulty experienced in securing quartz crystals of large dimensions this property of the Helberger produced quartz glass is of the highest importance. S. G. B.

79. *The Ultramicroscopic Investigation of Linear Elements.* **A. Szegvari.** (Zeits. phys. Chem. 112. pp. 277–316, Sept. 20, 1924.)—The construction and use of a suitable adjustable azimuthal stop to be placed in the condenser of the ultramicroscope are described, and it is shown that the method is very valuable in the investigation of sols containing ultramiscroscopic, rod-shaped particles. If the particles have a Brownian motion they flash out in the dark field when their length is perpendicular to the direction of the light, and if they are motionless they appear when the stop is in one position and disappear when it is turned through 90 degrees. The stop makes the ultramicroscopic investigation of boundary surfaces between two different media possible, enables fibres to be examined ultramicroscopically, and can be used with polarised light. The Mie effect may sometimes give the impression of an azimuth effect; this can be avoided by using a suitable adjustable aperture stop in the objective. This helps in observing the previously mentioned spark phenomenon. The rod-formed sols of vanadium pentoxide and benzopurpurine show bright and dark patches when examined in this way. If the stop is turned the bright patches become dark and the dark patches bright. In the bright patches a number of minute rods can be seen, all oriented perpendicular to the direction of the light, and there seems no doubt that the bright background is due to a swarm of unresolvable rod-like particles, all oriented in the same direction; thus the sol consists of separate swarms of particles, the particles of each swarm being oriented alike, so that each swarm has a structure of something the same nature as a fluid crystal, in which the molecules are oriented in the same direction, though in the swarm the particles are separated from one another by the solvent. The particles of these sols are quite mobile, and show a characteristic, limited, but constant Brownian motion. Other sols examined proved to be formed of rods, but did not show this structure. The polarisation of the light diffracted from the particle was investigated, and interesting results were obtained by this means.

H. N. A.

80. *Use of Screen in the Study of Optical Systems.* **V. Ronchi.** (N. Cimento, 1. pp. 209–214, July–Aug.–Sept., 1924.)—Discusses the theory of the use of a reticule in the study of an optical system [see Abstract 817

(1924)] and the conditions necessary for maximum sensitivity. It is shown that the necessity for screens of different pitches may be avoided by using different distances between the screen and the optical system.

J. W. T. W.

81. *Curvature of the Spectral Lines in a Prism Spectroscope.* **G. Subrahmaniam** and **D. Gunnayya.** (Phil. Mag. 48. pp. 896–898, Nov., 1924.)—The authors assume that the curvature of the spectral lines arises from the obliquity to the principal plane of the prism of the incident rays from the ends of the slit. The actual rays are projected on a great circle lying in the principal plane, with reference to the edge of the prism as the pole, and the deviation δ' in the projected path is related to the actual deviation δ by the equation $\sin \delta/2 = \sin \beta \sin \delta'/2$, where β is the inclination of the ray to the edge of the prism. δ' is always greater than δ, except when $\beta = \pi/2$. If $2l$ is the length of the slit, and d the distance of the collimating lens from the slit, the maximum possible divergence of the extreme ray is $\sin^{-1} l/(d^2 + l^2)^{\frac{1}{2}}$, and $\sin \beta = d(d^2 + l^2)^{\frac{1}{2}}$.

H. N. A.

82. *The Use of Celluloid in the Optical Method for Observing Strains in Structures.* **M. Wächtler.** (Zeits. techn. Physik, 5. 9. pp. 418–423, 1924.)—The experiments of Ambronn lead to the conclusion that celluloid is a most unsuitable material for the above purpose. He regards celluloid as a mixture of optically "positive" nitrocellulose and optically "negative" camphor crystals. At first these are mixed irregularly, and the substance is optically isotropic; if the substance is stretched the crystals become oriented, but the positively doubly refracting nitrocellulose is oriented more rapidly than the camphor, and at first the whole substance is optically positive; later it again becomes optically isotropic and finally negative. Ambronn replaced the camphor with xylol, and found that the effect was removed. The author has investigated both of these mixtures, measuring the double refraction $a = \gamma\lambda/d$, where γ is the phase difference between the ordinary and extraordinary rays in wave-lengths, and d the thickness, and gives curves for different wave-lengths. Even the xylol mixture does not show proportionality between the double refraction and the increase of length, while celluloid behaves as Ambronn has described. To account for the observations it is necessary to assume the existence of tension (or compression) double refraction and orientation double refraction. In some cases the latter is observed alone (when the load is removed); in others the observed double refraction is due to both causes. It is clear that, in view of this peculiarity, celluloid is not suitable for testing models of structures by the optical method.

H. N. A.

83. *Theoretical Interpretation of the Polarisation Experiment of Wood and Ellett.* **J. A. Eldridge.** (Phys. Rev. 24. pp. 234–242, Sept., 1924.)—Wood and Ellett [see Abstract 1861 (1923)] recently published some interesting results obtained in a study of the fluorescence of mercury and sodium vapours as affected by a magnetic field. The vapour is maintained at extremely low pressure, presumably thereby avoiding collisions during the time of excitation. It was illuminated by its polarised resonance radiation (λ2536 for Hg) and the plane of polarisation of the secondary radiation determined. In the case of mercury, the plane was radically influenced by comparatively weak fields. In explanation of the above observations it is suggested that, in accordance with Larmor's principle, the field causes a precession of the electric vibrators with an angular velocity $\frac{1}{2}(e/m)H$, and this precession is shown to be quite competent to explain the observation if a proper duration of the excited state or proper damping constant α is assumed. The experimental results for mercury λ2536 give a value for α of $1 \cdot 14 \times 10^7$ per sec.—in good agreement with other values. This classical theory is substantially the same as the classical theory of the Zeeman patterns, and does not account for the behaviour of lines showing a more complicated Zeeman pattern such as the sodium lines studied by Wood and Ellett. The fundamental fact of the fluorescent light being plane polarised is hard to reconcile with the assumptions of the quantum theory of atomic radiation. [See also Abstract 100 (1925).] A. E. G.

84. *Intensity and Polarisation of Light after Passage through Deep Slits.* **L. P. Sieg.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 201–209, Sept., 1924.)—Gives a theory of the effects upon a beam of light due to its passage through a narrow deep slit of conducting material. The theory is applied to copper, gold, silver, nickel, iron and silicon. It is shown that a slit having silicon jaws produces the greatest polarisation, one of silver the highest transmission. It is pointed out that the results are of interest in connection with the measurement of polarisation and intensity by means of any apparatus in which the light passes through a fine or deep slit. J. W. T. W.

85. *Some Properties of Ammonium Di-molybdo-malate.* **E. Darmois** and **A. Honnelaitre.** (Comptes Rendus, 179. pp. 629–632, Oct. 6, 1924.)—Ammonium di-molybdo-malate is strongly dextro-rotatory and possesses a characteristic rotatory dispersion. The acid salt possesses a maximum stability at a *p*H value of 3·5, and the presence of acids causes a marked lowering of the rotatory power, the effect being proportional to the strength of the acid. With strong acids there can result a lævo-rotation which attains a limiting value when it is unaffected by a further increase in the concentration of acid. The salt can be employed as an indicator to show the point of neutralisation of an acid by a base. On adding successive amounts of sodium hydroxide to hydrochloric acid in a solution containing the above salt the rotation increases and attains sharply a maximum value at the neutralisation point. In the case of some acids, notably with oxalic, a greater effect is exerted on the lowering of the rotatory power than would be expected from the affinity constant. This action is attributed to the formation of complexes which have characteristic values. The results are given of measurements showing the large variation in rotatory values given in the presence of different organic acids, the polyalcohols and polyphenols. [See Abstract 1358 (1923).] J. N. P.

86. *Rotatory Dispersive Power of Organic Compounds. XII. Octyl Alcohol and Octyl Oxalate.* **T. M. Lowry** and **E. M. Richards.** (Chem. Soc., J. 125. pp. 1593–1597, Aug., 1924.)—Measurement of the rotatory dispersion of octyl alcohol for nineteen wave-lengths by the visual method and for six further wave-lengths by the photographic method gives results expressible completely by one term of Drude's equation. With octyl oxalate, however, as with sodium tartrate, the results approximate to Biot's inverse square law, but cannot be expressed exactly either by that law or by one term of Drude's equation; in this case, then, the dispersion is not simple, but complex. T. H. P.

87. *Hyperbolic Relationship in Geometrical Optics.* **S. Bodócs.** (Zeits. f. Physik, 28. 2. pp. 114–128, 1924.)—Extends the validity of the hyperbolic law connecting the position of object and image when the optical system, whether dioptric or katoptric, moves along its axis. [See Abstract 2055 (1924).] J. W. T. W.

88. *Heterochromatic Photometry.* **C. Fabry.** (Rev. Gén. d'Él. 16. pp. 533–540, Oct. 4, 1924. Paper read at the Internat. Commission on Illumination, Geneva, July, 1924.)—Gives a general *résumé* of work on this subject during the past three years. The radiation from a black body has become more and more important, and may serve as a basis for the study of the spectral distribution curves of modern light sources. The use of coloured filters should be carefully investigated. The three-colour method has been further developed by Ives, while equalisation of tint by using the rotatory polarisation of quartz has been studied by Priest. The photometers of Yvon, Guild and Pulfrich (stereo-spectral-photometer) are briefly considered. J. W. T. W.

89. *Use of Coloured Screens in Heterochromatic Photometry.* **R. Jouaust.** (Rev. Gén. d'Él. 16. pp. 571–574, Oct. 11, 1924. Paper read at the Internat. Commission on Illumination, Geneva, July, 1924.)—Describes experiments on the use of coloured screens in heterochromatic photometry, particularly the use of Crova's solution. It is found that the use of such filters did not affect the precision of the results obtained by a single observer, neither did it reduce the differences between the results of different observers. The author considers that this is largely due to the wide extent of the transmission band of the filters worked with, and that the use of more nearly monochromatic filters might give improved results. J. W. T. W.

90. *Nature of the Radiant Energy from a Phototropically Treated Compound.* **Y. Venkataramaiah** and **A. Janakiram.** (Sci. Assoc. Maharajah's Coll. Vizianagaram, J. 2. No. 1. pp. 16–18, 1924. In English.)—Experiments conducted by the authors with hydrosulpho-mercuric sulphocyanide (HS. Hg. CNS.), iodo-mercuric sulphocyanide (I. Hg. CNS.), and trimercuric di-iodo disulphide ($Hg_3I_2S_2$) show that the reversion of these compounds to their original colour, after being excited in strong sunlight, is attended with radiations capable of affecting a photographic plate in the dark. These radiations do not affect a photographic plate through glass 0·12 in. in thickness nor across 20 cms. of air, and thus the radiations are not simply actinic, although a gold-leaf electroscope was not affected by them. All photographic plates are not sensitive to the radiations, but for such as are sensitive the positive was always printed. R. S. R.

91. *Influence of Light on Aqueous Solutions of Potassium Iodide, Nitrate and Chlorate.* **K. Suryanarayana.** (Sci. Assoc. Maharajah's Coll. Vizianagaram, J. 2. No. 1. pp. 12–15, 1924. In English.)—As the result of a series of experiments it was found that a solution of potassium iodide, if contaminated by oxygen, and even a weak, acid-like carbonic acid, will liberate iodine even in the dark, but the effect ceases in the absence of oxygen. When once started, the velocity of decomposition is dependent upon the intensity of the light and the hydrogen-ion concentration of the acid. Ultra-violet light decomposes solutions of oxy-salts like potassium nitrate and chlorate, liberating oxygen and forming nitrite and chloride. With the nitrate a steady state is soon reached, and action ceases. The equilibrium between potassium nitrate and nitrite depends upon the concentration and thickness of the solution of nitrate when the solution is not stirred during exposure to light. R. S. R.

92. *Investigations on the Latent Photographic Image. Part I. The Relation between the Light Frequency and Number of Developable Centres.* **F. C. Toy** and **H. A. Edgerton.** (Phil. Mag. 48. pp. 947–961, Nov., 1924.)—The relation between the number of developable centres (n) in a photographic emulsion and the wave-length (λ) or frequency (ν) of the light which produces them is one of the most important problems in photographic theory. The authors point out the apparent failure of Silberstein's light dart theory, and put forward the theory that the true relation between n and λ involves a consideration of the quantity of energy which is absorbed by the silver halide itself. The object of the present investigation was to determine whether the observed relation between the frequency and number of centres produced (with incident intensity and all other variable constant) could be explained by energy considerations and by the change in frequency, as such, which would be expected on the quantum hypothesis. The results given in the paper were obtained with extremely slow emulsions. The general conclusions arrived at were as follows: (1) By applying the laws of reflection and absorption to the case of a "single layer" photographic plate, the relative quantities of light energy, of different frequencies, absorbed by the grains when equal intensities of each are incident are calculable; hence the relative number of quanta absorbed is determinable. (2) Except at low exposures, the relative number of developable centres produced by different frequencies is equal to the relative number of quanta absorbed. (3) The departure from this equality at low exposures is believed to be due to the fact that development does not then give a true record of the extent of the light action. The results obtained are in good agreement with the recent work of Eggert and Noddack, on the proof of the Law of Photochemical Equivalence for dry plates. A. W. J.

93. *The Photo-chemical Decomposition of Gaseous Sulphur Dioxide.* **R. A. Hill.** (Faraday Soc., Trans. 20. pp. 107–112, Aug., 1924.)—The paper in question describes certain experiments made to test the validity of the view that when a substance shows chemical activity under the influence of light, then light of *any* wave-length which is absorbed by the substance (within the region of the band) will be effective in producing activity. The decomposition of sulphur dioxide gas under the action of light radiated from a uviol mercury-vapour lamp was investigated, and the resulting photostationary state, characteristic of a given set of conditions, determined, using a number of light filters. It was shown that the wave-length chiefly responsible for such decomposition of the gas was 313 $\mu\mu$. The shorter wave-lengths present in the source of radiation contributed very little to the decomposition. The wave-length 313 $\mu\mu$ lies within the first absorption band of sulphur-dioxide (at a pressure of 600 mm.), but does not correspond with the head of the band, already known to occur at 296·1 $\mu\mu$. The actual wave-length producing maximum decomposition depended upon the intensity distribution of the emission spectrum. Of the radiation emitted from the uviol lamp the longest wave-length capable of decomposing sulphur-dioxide is the 313 $\mu\mu$ line itself. The conclusion is drawn that any wave-length within the absorption band of the substance is capable of bringing about decomposition provided the intensity is sufficiently great. The bearing of the photochemical decomposition of sulphur-dioxide upon the critical increment of the thermal union of oxygen and sulphur vapour is discussed. It is concluded that the molecule S_2, as distinct from the atom, is involved in this process. A. W. J.

94. *Sensitising Action of Heat on Photographic Plates for the Infrared Ray.* **O. Masaki.** (Japanese Journ. Phys. 2. Nos. 6–10. pp. 163–165, 1923. In English.)—A preliminary reference is made to the work of Tóth, C. L. Acworth and others who have studied the problem of the photographic effect produced by raising the temperature of a dry plate, but it was considered that the results lacked completeness. In the present case the author shows that the raising of the temperature of a photographic plate has a sensitising action for the red and infra-red rays. The experimental method used to verify this point is described. The temperature of the plate, which was held in a special holder, was read from a thermometer placed close to the plate. The arc spectra of barium and potassium were photographed on the plate at various temperatures. It was found that the sensibility of the plate increased with rise of temperature, and reached a maximum at 105° C.; above this temperature fogging took place. For normal exposures the densities of the spectral lines in visible and near ultra-violet regions were increased by heating, but in the case of over-exposure, the heated plate showed a remarkable sensibility, especially towards the infra-red rays. The effect was very pronounced for plates of thin emulsion, such as lantern and process plates. An Ilford process panchromatic plate heated to 105° C. was found to record the spectrum lines up to 10,000 Å., and the ordinary process plate to 8000 Å. It is mentioned that a photographic plate of thin emulsion, such as process and lantern plates, when placed in a partial vacuum, decrease slightly their sensibility to the red rays, but increase greatly the contrast to such rays. A. W. J.

95. *The Luminescence of Phosphorus by Magnetic and Electric Fields.* **E. Rupp.** (Ann. d. Physik, 75. 3. pp. 326–336, Sept., 1924.)—The fading away of the illumination of an excited phosphor preparation may be explained (1) by supposing a heating of the whole phosphorus material, or (2) by the radiation of the stored-up phosphor light with not exciting light. The process of illumination consists not in a warming of the whole phosphor material, but in consequence of the strong absorption of the not exciting light in the excited phosphor centres there is caused a local molecular rise of temperature of those centres; the phosphorescence quickly falls off. Lately Gudden and Pohl have found illumination of excited phosphors by application of an electric field. F. Schmidt [Abstract 1934 (1923)] has examined this illumination quantitatively, and has sought to explain the phenomena by the bringing back of the illumination by the electric field through a change of motion of the electrons in the centres and through a rotation of the polarised pairs of metal atoms. In the present paper an illumination of the phosphors through *a high magnetic field* is described, and the relations of this with the lighting up due to the electric field is discussed. Hence and from the proved polarisation of irradiated phosphor light deductions as to the mechanism of the illumination in electric and magnetic fields can be drawn. In ordinary magnetic fields the effect referred to is not observed. It is first noticeable with fields of 20,000 gauss, but even with fields of 45,000 gauss the effect remains far smaller than with electric fields of 10,000 volts/cm. By imposition of a magnetic field during the decay of ZnS-phosphor a short-lived illumination is produced which is quite analogous to the behaviour in an electric field. The brightness of the illumination caused by a magnetic field at a definite time after the excitation increases with rising strength of field, analogously to the electric case. The luminescent light of a ZnS-phosphor by imposition of a magnetic field during the decay is partially polarised at right angles to the magnetic lines of force. The electron paths of the centre appear to be directly influenced by the magnetic field, and the polarisation is due to a certain rotation of the whole centre. The stronger polarisation observed with ZnMn compared with ZnCu may be due to the greater atomic magnetisation possessed by the Mn atom compared with the Cu atom. J. J. S.

96. *On Phosphorescence Excitation by High-frequency Radiation.* **E. Rupp.** (Ann. d. Physik, 75. 4. pp. 369–390, Oct., 1924.)—Assuming Lenard's photo-electric theory of phosphorescence, a conductivity change closely connected with the light emission, can be established by the excitation of phosphors with light or kathode rays as a consequence of inner photo-electric effects. Gudden and Pohl found by photo-excitation a parallelism between the spectral distribution of conductivity change and the light emission of the phosphor. This gave, by thermal expulsion of the stored phosphor light, the corresponding conductivity change proportional to the total emitted light. By excitation with kathode rays [see Abstract 968 (1924)] the author opines the possibility of tracing the cause of the major portion of the conductivity change to secondary kathode rays, and the present paper describes such an investigation with high-frequency rays (Röntgen and γ-rays). The problem is also investigated as to whether ether waves of great $h\nu$ value directly excite the phosphor photo-electrically, as known for light in ultra-violet processes, or whether the photo-electric electrons of higher velocity, liberated by high-frequency rays from the atoms of the entire phosphor material, cause the largest part of the light emission and conductivity change. A discussion is also included as to whether definite group-centres are preferentially excited by high-frequency rays, and whether the extinction effects known for light are also present. Since by high-frequency rays such electrons can be continually loosened from the metallic atoms capable of phosphorescence, whose velocity corresponds to the characteristic high-frequency radiation of the metallic atom, the investigation also affords information as to whether these electrons close to the nucleus of the phosphorescent metallic atom play a prominent part in the phosphorescence excitation by high-frequency rays, in comparison to the electrons released from the atoms of the filling material. On account of the feeble activity of the alkaline earth phosphors towards high-frequency rays, zinc sulphide, which exhibits a much superior behaviour, was chosen. Full experimental details with data are included. **H. H. Ho.**

97. *Fluorescence of Benzol Vapour under Monochromatic Excitation.* **P. Pringsheim** and **A. L. Reimann.** (Zeits. f. Physik, 29. 2. pp. 115–124, 1924.)—A recent paper by McVickers and Marsh [Abstract 1579 (1923)] has shown that it is possible with benzol vapour to obtain strong ultra-violet fluorescence when illumination by an iron spark or iron arc is used. In the present paper this work was repeated and an attempt was made to find traces of resonance. It was necessary, because of the short mean free path, to go to low vapour pressures. Actual observations were made at various pressures from atmospheric to 0·1 mm. Hg., the various pressures being obtained by adjusting the temperature. The result has been that no trace of a resonance spectrum could be obtained. At a temperature of 0° C., corresponding to the saturation pressure of about 25 mm., a canalised band fluorescence spectrum is always obtained, no matter what type of excitation is used. With pressures between 0·1 and 0·6 mm. bands are still obtained, although these are much weaker, these bands having no recognisable series relation either amongst themselves or with the exciting lines. As the pressures increase between these bands, other groups appear tending towards the complete band spectrum. Similar results are obtained by mixing foreign gases. At the higher temperature used of 25° C., which corresponds to a vapour pressure of 75 mm., the band fluorescence is restricted to the surface of the vapour. **J. R.**

98. *Atomic Rays.* **G. C. Schmidt.** (Ann. d. Physik, 75. 4. pp. 337–368, Oct., 1924.)—Gives details of the experimental methods and results on which the author's recent paper is based [see Abstract 240 (1925)]. The determination of e/m for the projected ions was carried out by Volmer. A beam of ions was produced by heating the salt in the lower portion of a glass tube, and applying a voltage of 2 to 8 volts to drive them to a small electrode connected to an electrometer to measure the charge; a magnet field was then switched on perpendicular to the beam, which was bent to one side to strike a second electrode. By this means the mass of the ion could be compared with that of the hydrogen atom. With CdI_2 the values of m_{Cd}/m_H obtained vary from 54 to 58·4, half the atomic weight A/2 being 56·2; with $CdCl_2$ $m_{Cd}/m_H = 57{\cdot}3$; CuI_2, m_{Cu}/m_H varies from 31·1 to 32·7, $A/2 = 31{\cdot}8$; $ZnCl_2$, $m_{Zn}/m_H = 32{\cdot}4$, $A/2 = 32{\cdot}7$; $PbBr_2$, $m_{Pb}/m_H = 108{\cdot}4$, $A/2 = 103{\cdot}6$; $CaFl_2$, $m_{Ca}/m_H = 20{\cdot}5$, $A/2 = 20{\cdot}0$. It appears, then, that each of these metallic ions carries a charge of $+2e$, where $-e$ is the charge of an electron. In addition to the points raised in the Zeits. Elektrochem. [Abstract 240 (1925)], which are dealt with at length in the present paper, the action of iodine and bromine on the salts is considered; these break up the large aggregates, such as Cd_nI_{2n}, and the number of ions increases. The way in which the current from the hot wire alters with the time depends at first on the increase in the emission of positive ions, owing to the above action of the iodine or bromine left behind in the salt; in the end, however, a badly conducting layer is formed on the wire so that the negative ions cannot easily give up their electricity, and the current drops. **H. N. A.**

99. *Polarised Resonance Radiation in Weak Magnetic Fields.* **R. W. Wood** and **A. Ellett.** (Phys. Rev. 24. pp. 243–254, Sept., 1924.)—The polarisation of light scattered by small particles and the general phenomena of scattering by turbid media, including the dependence of colour and of polarisation on the size of the scattering particles, was first observed by Tyndall. The present paper deals with the effect of weak magnetic fields, oriented in various directions with respect to the exciting beam, upon the polarisation of the resonance radiation of the vapours of mercury and sodium. A brief preliminary account of some of the results has been previously published [see Abstract 1861 (1923)]. In the case of Mercury λ2536 a beam of plane polarised monochromatic light is focussed on the bulb containing the vapour at low pressure (0° C.), and the polarisation of the resonance radiation is determined photographically with the aid of a quartz wedge and a double-image quartz prism. If the exciting beam is going east with the electric vector vertical, when the earth's field is carefully neutralised the polarisation is 90 % in any horizontal direction and zero vertically; a field of only 2 gauss directed north reduces the polarisation in its direction to nearly zero (the decrease with increasing field being exponential), changes the polarisation east and also up to 60 %, and increases the intensity directed upwards threefold. Similar effects are produced by fields in other directions. The polarisation with zero field does not approach 100 % at low pressures, since 90 % is found also with the vapour at − 50° C., when the radiation first appears. It was thought that the high value might be due to an orientation of the resonating atom by the field of the exciting light, but a beam of concentrated sunlight produced no effect. As found by Malinowski, a strong field of 10,000 gauss merely increased the intensity of the radiation about 10 %. This added light is found to be unpolarised. In the case of the sodium D line, the tube containing the sodium vapour is heated to 185° C.; the observations are visual, and as a source of unreversed light, the glow on the surface of a sodium glass vacuum tube carrying a discharge is used. The effects observed are similar to those for mercury, but differ for some directions; fields forty times stronger are required, and the polarisation in zero field is only 6 % probably due to traces of hydrogen. This is increased by the field in some directions to 30 %. In the case of the magnetic field, on fluorescent light of iodine vapour and on white scattered light from mercury and ether vapours the polarisation is found not be be affected. [See also Abstract 83 (1925).]

A. E. G.

100. *The Relative Absorbing Powers of the L Levels for Radiation of Varying Wave-length.* **H. W. B. Skinner.** (Cambridge Phil. Soc., Proc. 22. pp. 379–392, Sept., 1924.)—A description of the results of experiments on the absorption coefficient for individual L levels as varying with the wave-length of the absorbed radiation. The L levels of Ce excited by K-radiation of Cu, Mo, and Ag were used, a Seeman spectrograph being employed and attention being concentrated on the β_2 and β_3 lines. The main experimental conclusion is that when the Ce L spectrum is excited by Ag K-radiation, the line β_3 is distinctly stronger relative to β_2 than when the excitation is by Cu K-radiation. Thus when the wave-length of the absorbed radiation is about a quarter the wave-length of the absorption edge, the importance of the L_1 level as an absorber is appreciably increased relative to its value when the wave-length of the absorbed radiation is only just below those of the L absorption edge. The λ^3 laws are inapplicable to the case of the absorption by an individual L level. The results of experiments with γ-rays are shown to be in accord with the X-ray evidence, and in particular, when the wave-length of the γ-ray is 0·05 Å. or less, the L_{III} level is the most important absorber. The relationship between μ and λ is therefore very complex in the region of short wave-lengths. W. V. M.

101. *Broadening of Spectral Lines and the Stark-Effect.* **M. Kimura and G. Nakamura.** (Japanese Journ. Phys. 2. Nos. 3–5. pp. 61–75, 1923. In English.)—Stark proposed a theory to account for the broadening of spectral lines by increased current density in the light-source on the basis of the Stark-effect [Abstract 1071 (1914)]. The present paper compares the mode of broadening under increased current density with the Stark-effect for lines of oxygen, sodium, copper, silver, gold, magnesium, calcium, nitrogen, chromium, nickel and cobalt. In oxygen and elements having relatively low melting-points, the lines showing the Stark-effect were generally easily broadened in the spectrum of a heavy current arc or of a Geissler tube with heavy condensed discharge. Lines showing displacements towards the red in the Stark-effect broadened on the red side with increased current density, and so also for lines displaced towards the violet. A few exceptions are found. It is suggested that while most of the broadening can be accounted for by the electric field of the ions, a small part may be due to collisions during jumps from one orbit to another. A. C. M.

102. *Visibility of the Spectrum.* **S. Hecht.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 211–222, Sept., 1924.)—Suggests that the visibility of the spectrum depends upon the relative absorption of spectral light by the visual purple, whose absorption spectrum in watery solution has a maximum at 503 $\mu\mu$. Dissolved in the more refractive rods, its maximum is shifted to 511 $\mu\mu$, and in this position it controls the brightness of the colourless spectrum, while dissolved in the hypothetically still more refractive cones its absorption maximum shifts to 555 $\mu\mu$, and in this condition controls the brightness of the coloured spectrum. Experiments are being carried out to test this hypothesis. F. S.

103. *Intensities of the Components in the Zeeman-Effect.* **L. S. Ornstein and H. C. Burger.** (Zeits. f. Physik, 28. 3–4. pp. 135–141, 1924.)—This entirely mathematical paper deals with a generalisation of the rules already given [see Abstract 2070 (1924)] for the calculation of the intensities of multiplets, which enable the intensities of components in the Zeeman-effect to be predicted. A provisional experimental confirmation of these rules is announced. H. H. Ho.

104. *The Continuity of the Spectrum of Radiant Energy.* **G. Gueben.** (Assoc. Ing. El. Liége, Bull. 2. Ser. 7. pp. 261–277, July, 1924.)—There are many forms of radiant energy, electric rays, infra-red rays, visible light, ultra-violet rays and X-rays. These different regions of the spectrum of radiant energy have been studied at different times, and it has been established that the different forms of radiation have properties which differ only from the quantitative point of view and the continuity of the scale of radiations, from electric rays of the longest wave-length to X- and

γ-rays, the most penetrating, has also been established. As the result of the present investigations it is concluded that there is a continuity in the scale of radiant energy, and it is pointed out that this is an argument in favour of the modern theories on the constitution of matter. The oscillations of electrons in the atom in their passage from one orbit of stability to another orbit of stability produce in the ether a transport of electromagnetic energy analogous to that produced as the result of the oscillations of an antenna or, in general, of an open or closed oscillator.

A. E. G.

105. *Kathodo-luminescence of Fluorite.* **F. G. Wick.** (Phys. Rev. 24. pp. 272–282, Sept., 1924.)—The substances used were heated to a high temperature before exposing them to kathode-ray bombardment, since this causes more intense luminescence. Spectra were taken, which showed that the lines were due to rare-earth impurities. A. C. M.

106. *Doppler Principle and Bohr's Frequency Condition.* **P. A. M. Dirac.** (Cambridge Phil. Soc., Proc. 22. pp. 432–433, Sept. 1924.)—When an atomic system emits or absorbs radiation, Bohr's frequency condition $\delta E = h\nu$ applies. This equation is usually applied to the transition of an atom from one stationary state to another, the frequency of the radiation being measured in a frame of reference in which the atom as a whole is at rest, both before and after the transition. It has been pointed out by Bohr that difficulties arise when no natural frame of reference presents itself, which is the case for non-isolated systems, or even for isolated systems when the process of radiation is connected with a change of momentum. The question has been considered by Schrödinger [Abstract 20 (1923)], who assumes that the frequency condition holds for all frames of reference, and deduces an equation for the frequency in any frame of reference which he calls a generalisation of the Doppler principle. By making use of other relations given by Schrödinger this equation is transformed to $\nu' = \nu(c - v_1 \cos \theta_1)/\sqrt{c^2 - v_1^2}$. This shows that the law of transformation of ν is the same as that given by the ordinary Doppler principle for a source moving with velocity v_1 (and therefore for a source moving with any velocity). Hence, provided the emitted radiation is entirely directed, consistent results will be obtained whichever frame of reference is used for applying the frequency condition. This conclusion is proved more directly by showing that the frequency condition can be put in the form of a vector equation in four-dimensional space-time.

A. W.

107. *Band-Spectra and Molecular Structure.* **Y. Takahashi.** (Japanese Journ. Phys. 2. Nos. 3–5. pp. 95–110, 1923. In English.)—The formula developed by the author [see Abstract 1072 (1921)] for the frequency of radiation emitted in the transition from one state to another of a molecule consisting of two equal atoms vibrating along an axis passing through the nuclei and rotating about an axis perpendicular to the former is here applied to the resonance spectrum of iodine observed by Wood, the band-spectra of BeF_2, MgF_2, CaF_2 and SrF_2, the band-spectrum of helium and the quintuplet series of hydrogen worked out by Fulcher from the data of Merton. No relation is found between the bands detected by Croze and the Fulcher band, so that it seems probable that these series are due to different electronic transitions. F. S.

108. *Regularities in Band-Spectra.* **S. Datta.** (Phil. Mag. 48. pp. 673–692, Oct., 1924.)—An attempt to find a general equation which may explain the different types of series found to exist among band-heads. In the general formula for the frequency in terms of quantised energy changes, the change in the energy of rotation of the molecule can be left out, as it only gives the fine-structure. Considering changes in atomic vibration of one quantum at a time, and the final orbit of the form $(k + m)$, the equation $\nu = \mathrm{A} + \mathrm{B}m + \mathrm{C}m^2$ is arrived at, where B is small and C exceedingly small. This would give a close succession of heads with the interval slowly varying. This form of equation has previously been used empirically. If the discharge is more vigorous, the changes may take place more than one quantum at a time, with the final orbit as k, and this leads to $\nu = \mathrm{A} + \mathrm{B}n + \mathrm{C}n^2$, where $\mathrm{B} > 1000$, and C is greater than its value in the previous equation, though still a small number. This would mean a succession of heads with interval > 1000, varying faster than in the previous case. The third and fourth positive bands of nitrogen may correspond to this case. Finally, all possible primary states and all possible quantum changes may be expected. This gives a combination of the two; groups follow at long intervals, but the heads in each group follow at short intervals. The first positive bands of nitrogen are now grouped together in accordance with these formulæ, and criticisms are given of the band-arrangements of v. der Helm and Cuthbertson. The arrangement gives a general formula approximating to $\nu = 9244{\cdot}8 + m(274{\cdot}75 - 29{\cdot}0n) + (-0{\cdot}75)m^2 + 1748{\cdot}2n + (-14{\cdot}5)n^2$, where the constants are of the order predicted. The significance of the afterglow bands and the ionization potential measurements in nitrogen are discussed in the light of the theory. A. C. M.

109. *Line-Spectra Relationships in Band-Spectra.* **R. Mecke.** (Zeits. f. Physik, 28. 5. pp. 261–277, 1924.)—A new terminology is employed which emphasises the analogy between line- and band-spectra. Application to the second positive group of nitrogen gives five-fold terms for the neutral molecule, while the negative bands, which are attributed to the ionised molecule, give doublet terms. This necessitates new series formulæ. Bands possess multiplets determined by the core quantum-number R. A regular alternation of even and odd multiplets is shown to exist for the molecules as well as for the atoms in going through the periodic table; the molecular multiplets are even if the atomic ones are odd; and similarly for the "spark" and "arc" band-spectra. A. C. M.

110. "*Dashed*" *and Displaced Terms in Spectra.* **A. Landé.** (Zeits. f. Physik, 27. 3. pp. 149–156, 1924.)—In the building up of an element which can give x' terms as well as x terms, such as calcium, Bohr allots the orbits in this way. For ordinary terms the penultimate electron is put in a 4_1 orbit in ordinary terms, and in a 3_3 orbit for "dashed" terms; the last electron goes in n_2 orbits for both types. The author suggests a different arrangement in view of his treatment of complex terms [see Abstract 1863 (1923)]. He puts the penultimate electron in both cases in n_1 orbits; k is thus in both cases equal, being 1; the difference between ordinary terms and "dashed" terms must lie in the value of n. For x terms the penultimate electron is in an n_1 orbit; for x' terms in an $(n + 1)_1$ orbit; for x'' in an $(n + 2)_1$, and so on. The term if a p term will have $k = 2$, if a d term $k = 3$, for the azimuthal quantum number of the last-bound electron. In xx or $x'x'$ combinations the last electron alone jumps, and obeys the rule $k \rightarrow k \pm 1$. In mixed combinations (xx') it is the penultimate electron which jumps; the k remains equal to 1, and the total quantum number n changes. Various examples are given in support of this arrangement. Displaced groups of terms occur in spectra such as that of neon. Here it is not a case of n_k orbits of an inner electron with $k = 1$ and different values of n, but n_k orbits of an inner electron with $k > 1$, a constant value of n, but different inclinations of the orbit. This leads to different core-quantum numbers R for the displaced groups of terms, and therefore to different multiplicities—*e.g.* in neon there is a singlet-triplet system, while the displaced terms form a triplet-quintet system, and both together form an n^{1335} system. The radiation is emitted by the last-bound electron jumping in, changing $k \rightarrow k \pm 1$, while the n_k electron can either alter its inclination or not. In the case of higher "dashed" terms the size of the orbit of the penultimate electron will be greater than that of the last-bound electron. These two electrons will thus appear to have exchanged functions. There is thus an apparent difficulty as to why the penultimate electron should follow the rule $k \rightarrow k$ rather than $k \rightarrow k \pm 1$. This difficulty is discussed at length. A. C. M.

111. *A Test of a Spectrometric Method in the Infra-red.* **H. Witt.** (Zeits. f. Physik, 28. 3–4. pp. 236–248, 1924.)—Describes the construction of two small and sensitive bolometers and of a bismuth-tin thermopile made of bismuth wire, etched down to 0·05 mm. diameter, and pressed flat between glass plates. The alloy wires were prepared by a method previously described by the author; small rectangles of silver foil were soldered to the junctions with Rose's metal, the alternate rectangles forming radiation receivers. The thermopile was placed so that the receiving junctions were at the centre of an air-tight box of thick copper, with a slit 4 mm. wide in the cover, closed by a quartz plate; a silver cylindrical mirror at the bottom of the box concentrated all the more or less parallel rays passing through the slit, which missed the upper side of the silver receiver, upon its back. It was found that with the galvanometer coils suitably connected a candle flame at 6 m. gave a deflection of 190 scale divisions, with the scale distance 1 m. Gratings were constructed by silvering glass concave lenses and cutting fine lines in the silver on the dividing engine; alternate strips of silver between the lines were then removed by hand with a needle. In this way gratings with constants 0·9999 and 0·5163 mm. were produced, the width of the silver bands being 0·4335 and 0·1639 mm., the number of divisions 71 and 134 mm., and the radii of curvature 59·7 cm. The apparatus was mounted in Rowland's manner, with the screen and slit at the right-angled junction of two rods, on which slid the carriers for the grating and the thermopile, which were linked together by a rod of constant length. As source of radiation a hollow clay cylinder was used, wound with resistance wire, through which flowed a current which made the clay red-hot. A movable screen of rock-salt allowed wave-lengths less than about 12 μ to pass, but cut off longer wave-lengths, so that the difference observed by removing the screen is due to the long waves. For each point in the spectrum a large number of observations was taken, and the mean values were plotted in curves. One of these shows the energy distribution from 95 to 180 μ, with an entrance slit width of 5 mm., and others from 50 to 105 μ, slit width 5 mm., and from 50 to 60 μ, slit width 3 mm. The absolute humidity of the air varied from 5 to 6 mm.

A table shows the relation between the positions deduced for the absorption lines and those found by Rubens in the spectrum of the Auer burner and the quartz mercury lamp. H. N. A.

112. *Series in the Absorption Spectrum of Water-Vapour.* **H. Witt.** (Zeit. f. Physik, 28. 3–4. pp. 249–255, 1924.)—The experimental results described by the author in a recent paper [see preceding Abstract] show that in the region between 50 and $170\,\mu$ there examined, and down to $20\,\mu$ as investigated by other observers, the spectrum can be represented by two series of the form $\nu = a(n + \frac{1}{2})$, where a has the values 16·83 and 24·55. Owing to the fact that the water molecule consists of three atoms, it may be expected that three series exist, corresponding to the three principal moments of inertia of the molecule. The author examines the bands due to water-vapour, from wave-length 6500 to 9000 Å., which are observed as atmospheric lines in the spectrum of the sun, the differences of the three series for band I 8820 to 9150 Å., band II 7900 to 8500 Å., band III 7900 to 8200 Å., band IV 7200 to 7400 Å., and band V 6900 to 7200 are given in the following table:—

	Series 1.	Series 2.	Series 3.
Band I	—	23·1	56·8
" II	17·1	—	—
" III	17·8	23·7	57·1
" IV	18·0	24·9	57·0
" V	19·0	25·1	56·9

T. Heurlinger has found series in the ultra-violet of water-vapour with differences of about 34; this is almost exactly twice that shown above for Series 1, so that the carriers of this spectrum seem to have half the largest moment of inertia of the water molecule. It seems possible that they consist of OH ions. H. N. A.

113. *The Absorption Limits of the K-Series.* **F. J. v. Wiśniewski.** (Zeits. f. Physik, 28. 3–4. pp. 231–235, 1924.)—In a former paper the author has given a possible explanation of the K-absorption band-head of He, Li, Be, B and C [Abstract 2526 (1924)]; in the present paper he shows that this band-head follows a law, in the case of the heavier elements, which results from similar assumptions as to the structure of the absorbing elements. He assumes that this band-head is produced by the absorption of a quantum of energy, which suffices to break up a special arrangement of electrons, the K-arrangement, and remove its electrons to infinity. In this K-arrangement the electrons are divided between three rings surrounding the nucleus; the two outer rings have the quantum number four, and the inner one the quantum number two; two electrons revolve in the inner ring, and none in the first four-quantum ring, up to $Z = 6$; for $Z \geq 6$ the number of circulating electrons $= Z - 5$; the second four-quantum ring has one electron for $Z = 11$, and two for $Z = 12$. An expression is derived for the total energy of the electron arrangement, which is equal to $h\nu$; and a table is given for $Z = 2$ to 12, giving the observed voltages, the values of ν/R derived from these, the values of ν/R calculated from the above expression, and of p_2, p_4 and p'_4, the numbers of electrons in the different rings. For values of Z above 12 there are three electrons in a three-quantum ring, and Z − 13 electrons in a ring with quantum number ten up to Z = 29. For Z = 30 and up to 47 Z − 13 electrons are divided between two ten-quantum rings, so that for Z = 30 $p_3 = 3$, $p_{10} = 16$, $p'_{10} = 1$; Z = 31 $p_3 = 3$, $p_{10} = 17$, $p'_{10} = 1$; Z = 32 $p_3 = 3$, $p_{10} = 17$, $p'_{10} = 2$; Z = 33 $p_3 = 3$, $p_{10} = 18$, $p'_{10} = 2$; Z = 47 $p_3 = 3$, $p_{10} = 23$, $p'_{10} = 11$. The agreement between the observed and calculated values of ν/R is not as good for $Z \geq 30$ as for $Z \leq 29$, which may be due to the fact that, in the former case, the observed band-heads are not accurately determined. H. N. A.

114. *Ultra-violet Emission Spectra of the Halogens.* **E. B. Ludlam** and **W. West.** (Roy. Soc. Edinburgh, Proc. 44. 2. pp. 185–196, 1923–1924.)—The emission spectra of the halogens and halogen hydrides were examined in the ultra-violet, using the tesla-discharge in the gases, contained in silica tubes. Using small dispersion, two continuous bands are observed rising sharply on the long wave-length side ; the limits on the long wave-length side are :—

Cl....................	320 μμ	265 μμ
Br....................	370 μμ	295 μμ
I	480 μμ	345 μμ

Also a sharp line-spectrum was found for iodine, the first member being at 206·1 μμ. Taking the second band as the electron-affinity spectrum, the electron-affinities are calculated :—

Cl....................	107·3 cals.
Br....................	96·6 cals.
I	82·3 cals.

These are in agreement with the values calculated from the lattice theory. With the hydrides, the only addition was the hydrogen spectrum. A. C. M.

115. *Tesla-luminescense Spectra.* **W. H. McVicker, J. K. Marsh** and **A. W. Stewart.** (Phil. Mag. 48. pp. 628–636, Oct., 1924.)—An account of work in the spectra produced when the Tesla discharge is passed through different organic vapours. [See Abstracts 1148 (1923) and 278, 2276 (1924).] A. C. M.

116. *Tesla-luminescence Spectra. Part IV. Hydrocarbons with Single Benzene Nucleus.* **W. H. McVicker, J. K. Marsh and A. W. Stewart.** (Chem. Soc., J. 125. pp. 1743–1750, Sept., 1924.)—Disubstituted hydrocarbon derivatives of benzene, both open-chain and cyclic, and also styrene and phenylacetylene, are dealt with in this paper. The tesla-luminescence spectra are obtained as before [Abstract 1382 (1923) and preceding Abstract] except that a new Tesla transformer has been used, having the secondary directly coupled to the primary, and that a new all-quartz cell has been introduced.

Usually in the spectra showing banded structure the end of shorter wave-length is abrupt. Benzene, toluene, the three xylenes, and ethylbenzene all give intense spectra. When the substituent groups are increased in mass the spectra grow fainter, till in hexaethylbenzene the spectrum is faint. Similiar changes hold for the ethylbenzene and naphthalene types.

It is concluded that unsaturated cyclic substituents depress the luminosity, and that saturating the ring partly removes this. Other evidence is given showing that tesla-luminescence spectra are constitutional properties influenced by quite minor changes in the molecular structure, although certain broad general resemblances are found between spectra of the same family of substances. A. C. M.

117. *The Spectra of Monatomic Gases.* **G. Déjardin.** (Ann. de Physique, 2. pp. 241–327, Sept.–Oct., 1924.)—In a general discussion of the methods of production of spectra of gases, it is pointed out that the classical methods—flame, arc, spark, discharge in a rarified gas—are too complex for mathematical investigation. The method of electronic bombardment, however, furnishes a means of distinguishing between the arc spectrum and the spark spectrum of the first order, the velocity of the electrons necessary to cause the excitation of the gas and the potential difference to produce this velocity being quite distinct in each case. It also enables further orders of spectra to be examined which form the connecting-link between ordinary light waves and X-rays. The apparatus employed is a specially constructed form of three-electrode tube fitted up for spectroscopical examination of the rays of the visible spectrum and ultra-violet light. The vapours of mercury, helium, argon, krypton, and xenon are examined in this apparatus. For mercury the rays of the spark spectrum are sorted out into three groups, corresponding to potentials of 20-volt, 30-volt, and 44-volt. The first two appear to be due to the formation of the ion Hg^{+}; the third to Hg^{++}. The ionisation potential of helium is 24·5 volts, in good agreement with results of other investigators; the examination of "orthohelium" and "parahelium," commenced by other workers, has been extended to the ultra-violet regions. Mixtures of mercury and helium are examined, the influence of helium on the mercury spectrum being determined and discussed. For argon, krypton, and xenon five critical potentials have been observed in each case. The second of these corresponds to the normal "arc" spectrum, or first spectrum of the gas; the second spectrum is resolved into three separate groups, the first order and higher orders of the spark spectrum. The critical potentials of argon are proportional to the corresponding potentials of krypton, and with one exception, to those of xenon. The character of the various spectra observed affords good evidence of the analogous structure of the electronic envelope of these gases. For a detailed discussion of the significance of the various spectra and their bearing on the atomic structure of the gases the original paper must be consulted. The above results have been verified and amplified by experiments with an oscillating discharge in a tube without electrodes, developed by L. and E. Bloch, the spectra of argon, krypton, and xenon being examined. This discharge is accompanied by the emission of rays particularly rich in those belonging to the order of "spark" spectra, and furnishes a rapid and convenient method for the analysis of these rays. It is hoped to extend this work considerably in the near future. Many references to recent investigations on the subject dealt with are given and discussed with regard to the results quoted above. B. W. C.

118. *Low-Voltage Excitation of the Spectrum of Cæsium.* **A. L. Hughes and C. F. Hagenow.** (Phys. Rev. 24. pp. 229–233, Sept., 1924.)—While the Bohr theory suggests that individual lines should appear in regular succession as the corresponding voltages are reached, previous attempts to observe them have failed. In this study a large equipotential source of electrons was secured by fitting a nickel cylinder 10 cm. long over an alundum tube heated internally by a tungsten spiral. With this as kathode, currents up to a milliampere were used, the current density and also the space charge effects being small. With this tube heated so as to give a pressure of 0·01 mm., both visual and photographic observations showed definitely that lines in the principal series of Cs appear in the order and within 0·1 volt of the potential required by the theory. Lines in the diffuse and sharp series were more difficult to observe, but they also appeared below the ionisation potential, 3·9 volts. W. V. M.

119. *Self-reversal of the H_α and H_β Lines of Hydrogen.* **M. Kimura and G. Nakamura.** (Japanese Journ. Phys. 2. Nos. 3–5. pp. 50–59, 1923. In English.)—The writers observed in the course of study of the influence of iodine-vapour on the broadening of the Balmer lines that the H_α and H_β reversed easily when iodine was vaporised into the tube containing hydrogen at the pressure of a few millimetres and excited by a powerful discharge. With pure hydrogen a fine reversal of the line H_α could not be easily obtained, but the presence of water-vapour made the reversal easier. The effects of oxygen, chlorine, iodine and mercury in the tube containing hydrogen at a few millimetres pressure were to broaden out H_α and H_β considerably, and in some cases a faint reversal of H_β line was observed, but that of H_α was not. A further addition of hydrogen reversed the line H_α easily. An explanation is given in terms of the tendency of foreign gases to partially ionise the hydrogen, leaving it in a state to absorb the Balmer series. W. V. M.

120. *The Excitation of the Secondary Spectrum of Hydrogen by Electron Impacts.* **O. S. Duffendack.** (Astrophys. J. 60. pp. 122–132, Sept., 1924.)—The secondary spectrum of hydrogen was excited by two methods: (1) in a low-voltage arc in a mixture of mercury-vapour and hydrogen, and (2) by electron impacts in a three-element tube. The excitation of the spectrum below the ionisation potential, 16 volts, was studied in particular, and it was found that practically the entire spectrum developed below this voltage. The behaviour of the Fulcher bands and other groups was observed and differences noted. The first two Balmer lines were successively excited at their radiating potentials. The presence of monatomic hydrogen in the mercury mixture is accounted for by impacts of the "second kind" with excited mercury atoms. The conclusion is reached that there must be a characteristic ultra-violet spectrum due to the molecule whose initial state is identical with the final state of the molecule after the emission of the secondary lines. This conclusion is supported by spectroscopic investigations in the extreme ultra-violet and by investigations of critical potentials in hydrogen. The results indicate that the whole secondary spectrum is due to the neutral molecule, and that its excitation is not dependent upon the dissociation of the molecule. The minimum ionisation potential is about 16 volts, at which the molecule is dissociated into a neutral atom, an ionised atom, and an electron. AUTHOR.

121. *The Emission of Nitrogen and Hydrogen in the Infra-red.* **A. H. Pfund.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 193–196, Sept., 1924.)—The paper is a preliminary note on the results obtained from a study of the infra-red emission of the above gases, excited to luminosity in a vacuum tube and studied by means of a rock-salt spectrometer and a vacuum thermopile. The Paschen and Brackett [Abstract 324 (1923)] lines are confirmed, and a small maximum intensity found at 7·40 μ corresponding to

$$1/\lambda = 109{,}677\cdot 7\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \text{ and } n_1 = 5 \text{ and } n_2 = 6$$

i.e. the O series of X-rays. W. V. M.

122. *Intensity Measurements in Flame Spectra.* **C. E. Bleeker** and **I. A. Bongers.** (Zeits. f. Physik, 27. 3. pp. 195–202, 1924.)—The intensity-ratios of several lines of both subordinate series of rubidium and cæsium have been measured. As a result it is found that the ratio is independent of the concentration of the salt in the flame and independent of the temperature of the flame, the actual value of the ratio of the doublet intensities being 1 : 2. The method of comparison used was that described in Abstract 1390 (1923). A. C. M.

123. *Mass Spectra of Zirconium, etc.* **F. W. Aston.** (Nature, 114 p. 273, Aug. 23, 1924.)—Zirconium gives lines at 90, 92, 94, and (96) doubtful, with intensities 10, 2, 4, (1) respectively. This detection of the zirconium mass lines was only possible under very favourable conditions with most sensitive plates. Lines due to CBr at 93, 95 helped the measurements; there was no asymmetry in the spacing, so that the Zr values must be integral with the Br values, *i.e.* less than whole numbers by about one-tenth of a unit. The atomic weight of Zr will be 91·4 or 91·2, according as (96) is included or not. Cerium has a strong component 140 and a weak 142. Neodymium consists of 142, 144, 146, (145).

Barium 136 has been obtained very faintly, but no evidence of any lighter isotopes; 137 may also be there, but 138 is always so strong that resolution is impossible, so the low atomic weight (137·37) remains unexplained.

Si^{30} is now certain, and a little less intense than Si^{29}, in agreement with Mulliken's observations on band-spectra. A. C. M.

124. *Some Wave-lengths in the Vacuum-Arc Spectrum of Titanium.* **H. Crew.** (Astrophys. J. 60. pp. 108–121, Sept., 1924.)—Wave-length measurements in the vacuum-arc spectrum of titanium, from λ3653 to λ6366. Measurements have been made of 700 known lines and of 78 new lines, apparently belonging to titanium. The temperature control, using a new form of toluene thermostat, is believed to keep the temperature of the grating constant to within 0·01° C. Wave-lengths are given to 0·001 A. A discussion of the relative merits of the Rowland and Littrow mountings is included. AUTHOR.

125. *Spectra of Constricted Arc of Metals.* **T. Takamine** and **M. Fukuda.** (Japanese Journ. Phys. 2. Nos. 3–5, pp. 111–119, 1923. In English.)—A few lines of the type $2p_i - mp_i$ were observed in the flame arc of mercury in vacuum by Dingle [see Abstract 886 (1922)]. These lines correspond to change of azimuthal quantum-number zero, and hence their appearance is forbidden in the usual mode of excitation by the principle of selection. It is likely that the appearance is due to the close gathering of atoms and molecules in the narrow flame, so that the electric field of neighbouring ions and electrons comes into play. A special vacuum arc with a constriction was made, and the spectra of mercury, zinc, cadmium and thallium examined for forbidden lines in the region λ3000 to λ2100 Å. Two Hilger quartz spectrographs were used, and the photographs resembled those of the Stark-effect in mercury. In the case of mercury, besides a number of spark lines, a certain group of arc lines whose series relations are unknown appeared with marked intensity at the constriction. For cadmium and zinc the diffuse series lines were observed to higher term numbers than are given by Paschen and Götze. Many new combination lines were formed for thallium. F. S.

126 *Absorption Spectra of Vapours of Lead and Tin.* **N. K. Sur** and **R. K. Sharma.** (Sci. Assoc. Maharajah's Coll. Vizianagaram, J. 1. No. 4. pp. 121–124, 1924. In English.)—The metals were vapourised in a cast-iron tube, 40 cms. long, with quartz lenses as windows, which was heated in a coal oven. The tube was placed between a carbon arc and the slit of a small Hilger quartz spectrograph. Lines at 2170, 2247, 2614, 2802, 2823, 2833, 2873, 3240, 3640, 3684 and 4058 Å. were obtained as reversals in the absorption spectrum of lead, while only λ2707 Å. was observed in the case of tin. F. S.

127. *Spectra of Mercury from Various Parts of a Discharge Tube.* **G. Nakamura.** (Japanese Journ. Phys. 2. Nos. 3–5. pp. 77–83, 1923. In English.)—A tube of special shape was used, having a very fine piece of capillary tubing wedged into the tube. At a moderate pressure a globular glow was observed at the kathode end of the capillary; the spark lines in this glow were much enhanced. At the same time lines at the surface of the kathode were broadened. Diffuse series lines are generally stronger in the globular glow and extend farther from the end of the capillary; sharp series lines are fainter and shorter. Spark lines appear as short lines. It is supposed that the capillary causes the electric field to be intense in the neighbourhood of its end. The shorter lines would then be those which require greater energy. The diffuse series lines therefore require less energy for excitation than the sharp. The lines broadened at the surface of the kathode do not appear necessarily to be those showing the Stark-effect. A. C. M.

128. *Phenomena of High-frequency Radiation.* **de Broglie.** (Phys. Soc., Proc. 36. pp. 423–428, Aug., 1924. Ninth Guthrie Lecture.)—After brief reference to diffused and fluorescent light and corpuscular rays, the effects of high-frequency rays, such as X-rays, are discussed with regard to the atomic model of Rutherford and Bohr. It is pointed out that the detailed study of photo-electrons allows us to gain information in regard to the Bohr levels, and, consequently, to discover a series of data which are the key to all possible emission phenomena relating to the atom under consideration. Experimental methods of investigation are outlined, and reference is made to the work of Compton on diffused secondary X-rays. Compton's results show that the diffused secondary rays have a longer wave-length than the exciting rays, the difference in wave-length varying with what may be called the diffusion angle. Other experimenters have recently cast some doubt on the validity of Compton's results, but the author, working especially with tungsten lines ($\lambda = 0{\cdot}2$ Å.) incident on a secondary radiator of special form, and Dauvillier, using an improved apparatus with a silver target illuminating various types of radiators, have obtained results which confirm Compton's views. A. W.

129. *X-Ray Spectrographic Researches on the Existence of Swelling in Some Substance which Give a Debye-Scherrer Diagram.* **J. R. Katz** and **H. Mark.** (Phys. Zeits. 25. pp. 431–435, Sept. 1, 1924.)—Katz has recently shown [see Abstract 2781 (1924)] that with cellulose, cellulose hydrates, and silk fibroin with swelling in water there is no demonstrable alteration of X-ray identity period. In the present experiments on substances which are free from secondary complications, inulin in water shows a swelling which passes into the lattice and increases it. An alteration of 8 to 11 % is found in the size of the elementary bodies. It is, however, confirmed that swelling may be either inter-mizellar or intermolecular as found previously by Katz, and that each case has to be considered separately. A. E. G.

130. *A General Quantum Theory of the Wave-Length of Scattered X-Rays.* **A. H. Compton.** (Phys. Rev. 24. pp. 168–176, Aug., 1924.)—In recent papers the writer and independently P. Debye have developed a quantum theory of the scattering of X-rays by light elements. This theory is based on the idea that an X-ray quantum proceeds in a definite direction, and is scattered by a single electron. The quantum loses energy due to the recoil of the electron, and is thus reduced in frequency. Measurements of the wave-length of scattered X-rays by the writer [see Abstract 551 (1924)], Ross and by Davis have shown that at least in many cases scattered X-rays occur whose wave-length is changed by the theoretical amount. Moreover, electrons moving in the direction of the primary beam with about the velocity predicted for the recoiling electrons have been found by C. T. R. Wilson and by Bothe. There is thus strong evidence that in some cases X-rays are scattered in essentially the manner described by the quantum theory. Very recently, however, Clark and Duane and Clark, Duane and Stifler have shown the existence of a type of secondary radiation whose wave-length is altered more than this quantum theory demands. The theory previously presented gave for the change of wave-length due to scattering, assuming each quantum scattered by a single free electron, $\delta\lambda_F = (h/mc) \text{ vers } \phi = 0{\cdot}0242 \text{ vers } \phi$, where ϕ is the angle between the primary and scattered ray. This theory is now extended to scattering by bound electrons. If the scattering electron is not ejected from the atom, no energy is transferred and no change of wave-length occurs; but if the electron is removed, the change of wave-length must lie between $\delta\lambda_B = \lambda^2(\lambda s - \lambda)$ and ∞, where λ is the incident wave-length and λs the critical ionisation wave-length for the scattering electron in its original orbit. If we restrict the theory by assuming that the final momentum possessed by the residual atom is that acquired during the absorption from the incident beam, of the energy $hc/\lambda s$ required to remove the electron from the atom, and that the electron, now free, receives the impulse resulting from the deflection of the quantum, the resulting change of wave-length is $\delta\lambda = \delta\lambda_B + \delta\lambda_F$. Comparison with experimental results show that the restricted theory accounts satisfactorily for scattering by the lighter

elements and also for the scattering of tungsten rays by Mo if for heavy elements $\delta\lambda_F$ is taken to be zero. Criticism of the "tertiary radiation" hypothesis, which leads to the expression $\delta\lambda = \lambda^2(\lambda s - \lambda)$, shows that it does not account for the large percentage of polarisation for the large relative intensity and for the homogeneity of scattered X-rays.
A. E. G.

131. *X-Ray Spectra.* **M. Siegbahn** and **R. Thoraeus.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 18. 24. pp. 1–6, 1924. In German.)—The longest wave-lengths hitherto measured have been from 12·22 to 13·31 Å.U. The authors have extended this to as much as 43·96 Å.U. In the investigation of the M series of tungsten, out of seventeen possible one is missing and five pairs could not be discriminated with the dispersion available.
A. D.

132. *Irregularity of the Lα Doublet in X-Ray Spectra.* **B. B. Ray.** (Phil. Mag. 48. pp. 707–711, Oct., 1924.)—The atoms according to Bohr can be imagined as built up in complexity by the addition of electrons to outer shells. The addition of an electron to an outer shell will have less effect in the inner shells, the greater the number of shells. Consequently the effect of the addition of an electron to an outer shell in a complex atom should be very small. Consequently one would expect to find that the increase in $d\lambda$ of the Kα doublet is more rapid for small atoms than for heavy ones, and in the latter the value of $d\lambda$ tends to constancy. But sometimes the added electron forms a more stable configuration by going into an inner shell. One would therefore expect an irregularity at this point in the $d\lambda$ of the Kα doublet.

Such changes were found previously. In higher elements, where the added electron may pass into the N-shell, one might expect an irregularity of this sort in the progression of values of the Lα doublet. Such an irregularity is now found.

From calculations it is found that both Lα, and Lα_2 change in the same way. On the ordinary view, Lα_1 is due to a jump from the 3_3 orbit to the 2_2 orbit, whereas α_2 is due to a jump from the 3_2 to the 2_2 orbit. Consequently it would seem probable that α_2 should change more than α_1 since the orbit 3_2 is elliptical and 3_3 is circular. This is found not to be so. This would then fit in with Lande's suggestion that both the M_1 and M_2 orbits have the same shape, but different orientations.
A. C. M.

133. *The Graphical Interpretation of X-Ray Photograms.* **E. Schiebold.** (Zeits. f. Physik, 28. 6. pp. 355–370, 1924.)—A general discussion of the graphical methods for the interpretation of various types of X-ray crystal photographs. Thus aids to the elucidation of crystal structures from the ordinary Laue photographs using different methods of projection are discussed, while diagrams are produced from which the indices of planes of reflection may be determined directly from the position of the diffracted image. A general discussion of the coordinates of this image for any crystal lattice is attempted, but the examples are confined to the cubic lattices. Graphical methods for the results of experiments using the Debye-Scherrer method are described, and again direct methods for obtaining the indices by a comparison with constructed scales are given, provided the crystal is either body-centred, face-centred, a simple cubic arrangement or a diamond lattice. The paper contains some fifty references to the literature of the subject. W. V. M.

134. *Dependence of X-Ray Emission on the Form of the Discharge.* **M. Müller.** (Zeits. f. Physik, 28. 3–4. pp. 146–168, 1924.)—On the basis of Behnken's formula [see Abstract 1992 (1921)] the author has calculated the energy distribution in the X-ray spectrum. The deformation of the current and voltage characteristics in the tube are experimentally proved, their effect and that of the filter on the energy distribution being examined also. **Errata** (ibid. 30. 4 and 5. p. 340, 1924). A. B. W.

135. *X-Ray Doublet Separations in Optical Spectra.* **I. S. Bowen** and **R. A. Millikan.** (Phys. Rev. 24. pp. 209–222, Sept., 1924.)—Many of the lines which are strong in hot-spark spectra are due to atoms stripped of all valence electrons save one, which by its transitions gives rise to the radiation [see Abstract 2772 (1924)]. Some doublets have now been attributed to atoms having only one L electron, viz. Li(I), Be(II), B(III), C(IV), and it is found that the doublet separation varies in accordance with the relativity formula for X-rays: $\partial\nu = K(Z - s)^4$, where K is 0·365, and the screening constant s varies from 2·02 for Li(I) to 1·86 for C(IV). Similarly other L doublets are found which are attributed to atoms stripped of all but three electrons, and these obey the same formula but with the s increased about 20 %. Triplets occur due to atoms stripped of all but two or four electrons; the widest separations give values of s which agree with the values got for one, three, or five electrons.

Results of the same type are found for M doublets and triplets. Irregular L and M doublets (transitions from the 2s and 3s levels) obey the same law as for X-ray irregular doublets. These relations make it possible to predict the value of s for a given series for a given atom; examples are given of the assignment on this basis of certain L doublets to nitrogen and oxygen atoms at different stages of ionisation. Alternatively, the state of ionisation of the atom can be determined from its value for s given by the doublet or triplet separation. The relativity doublet formula is thus shown to hold for orbits having the same azimuthal quantum number. Also the relativity formula is extended to orbits usually considered as "optical." A. C. M.

RADIO-ACTIVITY.

136. *Chemical Action produced by Radon. Revision of the Chemical Effect of Recoil Atoms.* **S. C. Lind** and **D. C. Bardwell.** (Am. Chem. Soc., J. 46. pp. 2003–2009, Sept., 1924.)—It was previously shown by one of the authors that the recoil atoms from alpha-radiation of radon (and of its decay products) produce chemical action in general agreement with their ionisation. The reaction studied was the combination of electrolytic gas. In more recent work [see Abstract 559 (1924)] radon was employed when confined in an α-ray bulb, which does not allow recoil atoms to pass. In making comparison of the amount of reaction produced under these conditions with that when radon is mixed with the gases being acted on, it was necessary to correct for the recoil atom effect. A re-examination of this effect is therefore undertaken with the following objects: (1) To confirm its reality by directly proving that when recoil atoms are absent the chemical effects attributed to them are also absent ; (2) to remove a certain discrepancy between the recoil-atom effect and the " average-path " law ; (3) to redetermine the quantity of the recoil-atom effect at various pressures and to attempt to extend the measurements to lower pressures than previously attained. It is shown that the velocity constants for the combination of electrolytic gas in a 1-cm. bulb show no abnormal increase at low pressures when the radon is confined at the centre of the sphere in an α-ray bulb, whichcompletely stops the recoil atoms. Thus the earlier view is directly supported that it is recoil atoms which produce the excess reaction observed when radon is mixed with the gases under conditions otherwise the same. Revision of the data for the combination of electrolytic gas in bulbs of various sizes has eliminated an apparent discrepancy between the recoil-atom effect and the law of the inverse square of the diameter. A further study of the recoil-atom effect in small spheres at very low pressures is made. The experimental results confirm those previously reported down to pressures where the observed velocity of reaction is three times the normal velocity. For electrolytic mixture of hydrogen and oxygen the α-ray effect equals the recoil-atom effect at 117 mm. pressure in a bulb 1 cm. in diameter. The departures from the calculated values at very low pressures remain to be explained. A. E. G.

137. *The Distribution of Range of α-Particles from Polonium in Oxygen and Nitrogen.* **Irène Curie** and **N. Yamada.** (Comptes Rendus, 179. pp. 761–763, Oct. 20, 1924.)—Using the Wilson expansion apparatus, one of the authors [Abstract 1408 (1923)] has previously studied the distribution of range of the α-particles from polonium in air. The result obtained differed considerably from that furnished by the scintillation method, and in explanation it was suggested that the latter method becomes unreliable as a detector when the majority of the rays approach the end of their range. The range of the α-rays is distributed according to the law of probability, such that the number which have a range lying between x and $x + \delta x$ is proportional to $n = ke^{-\frac{\xi^2}{\alpha^2}}$ where $\xi = x - \rho$, where ρ is the most probable range. It was found that $\rho = 3\cdot85$ cm. (in dry air at 15° C. and 760 cm. press.) and $\frac{\alpha}{\rho} = 0\cdot015$, which gives $\alpha = 0\cdot60$ mm. The accuracy in α is 5 %. 10 % of the total α-particles do not agree with this probability distribution. Their range is a little less than the most probable range.

The work has now been extended to oxygen and nitrogen, with results similar to those for air. In this case $\frac{\alpha}{\rho} = 0\cdot0208$ in nitrogen and $= 0\cdot0208$ in oxygen, as compared with 0·015 in air. The reason for the remarkable difference between α/ρ for air and nitrogen or oxygen is discussed.

A. B. W.

138. *Sklodowskite : A New Radio-active Mineral.* **A. Schoep.** (Comptes Rendus, 179. pp. 413–415, Aug. 18, 1924.)—This mineral is found in the Belgian Congo, and consists mainly of UO_3 (63–64 %) as a hydrated silicate, with small proportions of MgO, Na_2O, K_2O, NiO, and TeO_3. It occurs in fissures in siliceous rocks as pale yellow translucent acicular crystals, very similar to uranophane. The crystals belong to the orthorhombic system, are optically negative, and have a very marked dispersion. Indices of refraction: $\alpha = 1\cdot613$; $\beta = 1\cdot635$; $\gamma = 1\cdot657$. Density, 3·54. A. B. C. L.

139. *Early Days in Radio-activity.* **E. Rutherford.** (Frank. Inst., J. 198. pp. 281–290, Sept., 1924.)—A brief account is given, on the occasion of the presentation of the Franklin Medal, of the author's reminiscences in the early days of radio-activity. An interesting history is given of the genesis and development of the author's researches in the field of radio-activity. A. B. W.

140. *Quantum Theory of Radio-active Transformations. Part II.* **A. Smekal.** (Zeits. f. Physik, 28. 3–4. pp. 142–145, 1924.)—It is shown that L. Meitner's theory [Abstract 2793 (1924)] of the successive transformation of radio-active substances is in agreement with the author's quantum theory. A. B. W.

141. *The Collision of α-Particles with Light Atoms.* **M. Akiyama.** (Japanese Journ. Phys. 2. Nos. 6–10. pp. 279–286, 1923. In English.)—Rutherford, Chadwick and Bieler [see Abstract 920 (1922)] and others have shown that the theory of collision of α-particles, based on the ordinary dynamics and the law of inverse square of electrostatic force, is not applicable to the case of intimate collision with light atoms. Many investigations have since been made to ascertain the actual mode of collision by means of the cloud method of C. T. R. Wilson. In continuation of a previous experiment, the author, also utilising the same method, took stereophotographs of the tracks of α-particles emitted by actinium emanation and its direct product of disintegration. Of these tracks, about seventy show sudden deflections, nine of them having spurs. On examining their paths closely, some cases are met with which may be considered anomalous and need particular explanation. The method of the experiment is essentially the same as that in the previous experiment. It is pointed out that the path of the recoil atom does not lie on the plane containing the path of the colliding α-particle before and after collision. This is a fact difficult to explain upon the basis of the conservation of momentum. In order to explain the result of the recent investigation on the passage of α-particles through hydrogen, Rutherford considers that the α-particle might be of a plate form, and the inverse square law of electrostatic force might not hold good in the case of an intimate collision, while Chadwick and Bieler discuss on the supposition that α-particles are of oblate spheroid and suffer elastic collision. Whatever may be the form of the α-particle and that of the nucleus, and also the law of force acting between them, be it electrostatic, magnetic, or elastic, the argument here given will not be affected, provided that the translational velocity of the nucleus is small compared with that of the colliding α-particle. As a possible cause of the anomalous collision, so long as the Newtonian dynamics is valid, it might be anticipated that, when an atom is collided violently by an α-particle its nucleus is liable to give rise to a kind of radiation, the atom itself attaining an additional momentum in the direction opposite to that of radiation. Complete theoretical considerations are almost impossible, as the experimental data are not sufficient and the mechanism by which the radiation is excited is at present quite unknown.

A. E. G.

142. *Recoil of Radio-active Atoms.* **M. Akiyama.** (Japanese Journ. Phys. 2. Nos. 6–10. pp. 287–289, 1924. In English.)—The author has shown [see preceding Abstract] that when an α-particle collides with a light atom, this recoils in some cases in a direction which does not lie on the plane containing the initial and final paths of an α-particle. It is conceivable that when an atom of radio elements disintegrates by expelling an α-particle, the recoil might take place in a direction which is not exactly opposite to that of the α-particle. To see if this is actually the case, the author has taken, by means of the cloud method of C. T. R. Wilson, a number of stereophotographs of the tracks in hydrogen at a reduced pressure (final pressure about 10 cm. of Hg) of recoil atoms of actinium A and B. On these photographs the tracks of recoil atoms appear much thicker than those of α-particles, and can easily be distinguished from the latter. Although in the majority of cases the tracks of an α-particle and the corresponding recoil atom lie on a straight line, in the remaining cases they are seen decidedly to deviate from this. The extreme deviation observed is about 15 degrees. At the present stage it is not possible to find the distribution of deviation over the whole range of angles. The number of cases in which the deviation exceeds 8 degrees is found to be 22 out of 82 investigated. The cause of this deviation is considered. A. E. G.

143. *The Recoil Effect of Electrons which Scatter γ-Rays.* **D. Skobelzyn.** (Zeits. f. Physik, 28. 5. pp. 278–286, 1924.)—The author has shown in a previous paper that, for observations on recoil, very hard rays are desirable, and that γ-rays are particularly suitable [Abstract 2282 (1924)]. With γ-rays of about 0·02 Å. wave-length the energy given to the electron may approach $h\nu$ when the "collision" is central, or may be nearly the same as that of a photo-electron; the energy, however, varies with θ, the angle between the direction of the primary ray and that of recoil, and the velocity of recoil may have any value between 0, for $\theta = \pi/2$, and the maximum. Thus if Wilson's cloud method is used, the paths of the electrons may be expected to vary from several decimetres down to very small lengths. In using the above method the author sends a very narrow beam of γ-rays through the cloud chamber, so that the horizontal walls are completely screened from the action of the γ-rays. To eliminate the effect of emission of electrons from the side walls a vertical magnetic field was employed, which bent the paths of the electrons into spirals, and in some cases nearly into circles, so that the paths of those originating in the gas were separated from those coming from the walls. In addition to long paths, very short paths of the order of a centimetre or less appear in the photographs, even when a thick lead screen was used to cut off soft rays. It was found that the original velocity of the electrons has always a forward component; the energy of the electron depends on the angle θ, and is on the average smaller for larger values of θ. These facts agree with Compton's hypothesis, according to which the secondary β-rays, which are produced by γ-rays from light atoms, are recoil rays. The hypothesis of C. T. R. Wilson and Bauer, that the scattering takes place in the form of a spherical wave, and that the whole of the elementary impulse of the radiation is given to the electron, cannot be correct. H. N. A.

144. *The High-Energy Groups in the Magnetic Spectrum of the Radium C β-Rays.* **C. D. Ellis.** (Cambridge Phil. Soc., Proc. 22. pp. 369–378, Sept., 1924.)—Rutherford pointed out some time ago that the high-energy lines of the Radium C β-ray spectrum showed the existence of γ-rays of very high frequency, and later that these frequencies must be closely connected with the β-ray energies through the quantum relation. This is verified in the paper, and the results of energy measurements on a large number of β-ray spectral lines are classified and analysed. It is concluded that the L lines originate in the L_{II} sub-group. The most striking feature of the analysis of Radium C β-ray spectrum is that γ-rays of $1\cdot 5 \times 10^6$ volts and probably 2×10^6 volts show no fresh absorption phenomena, *i.e.* no evidence of nuclear conversion of radiation for Radium C. Thus it was thought that the various γ-ray levels did not differ from the X-ray levels in anything but complication and magnitude of the energy changes, but it now appears that there must be a real essential difference, shown by the fact that there is no appreciable absorption. A system of energy levels for the Radium C nucleus is suggested. W. V. M.

145. *Experiments with an α-Particle Counter.* **E. V. Appleton, K. G. Emeléus and M. A. F. Barnett.** (Cambridge Phil. Soc., Proc. 22. pp. 434–453, Sept., 1924.)—This paper describes experiments made to elucidate the action of Rutherford and Geiger's α-particle counter [Abstract 1627 (1908)]. The normal counting circuit, including an ionisation chamber with point and plane electrodes, was used. The wave form and intensity of the transient impulses resulting from discharges stimulated by single electrified particles have been determined, using a kathode-ray oscillograph. The nature of the impulse is determined largely by the capacity and resistance of the system, and not by the nature of the electrical stimulus. The potential impulse normally detected by string electrometer methods is shown to be proportional to the current responsible for the recharging of the electrostatic capacity of the counter after the rapid discharge of the capacity initiated by the electrified particle. An explanation is given of the function of the high circuit resistance in causing the system to be self-restoring after a discharge.

Effect of Pressure.—When the pressure in the ionisation chamber is made less than that at which self-restoring action is possible, persistent oscillations are found, the frequency varying with the pressure and also with the circuit capacity and resistance. Oscillograms showed these oscillations to represent the periodic charging and discharging of the counter capacity. The impulses normally produced by α-particles are thus represented by one unit of the sustained oscillation. Measurements were made of the total quantity of electricity circulating round the system when an α-particle enters the chamber. In normal cases this is of the order of 10^{-10} coulombs, but in low-resistance circuits it may be as high as 10^{-6} coulombs. A. W.

HEAT.

146. *The Heat Conductivity of the Technically more Important Metals.* **M. Jakob.** (Zeits. f. Metallkunde, 16. pp. 353–358, Sept., 1924.)—In compiling the conductivity tables for Landolt and Börnstein's *Physikalisch-Chemischen Tabellen,* the author thought it necessary to include values obtained by different experimenters, which differ by as much as 100 %, greatly reducing their value for technical purposes. He has now compiled tables, based mainly on those of Landolt and Börnstein, but containing a few recent determinations, giving definite values suitable for practical work, and if possible an estimate of the uncertainty due to errors in measurement and variations in the material. With the exception of silver, only metals and alloys of importance in machine construction and the metal industry are included, and values are given in many cases from temperatures approximating to that of liquid air, which may be important in refrigeration, up to 900° C., which may be useful in designing internal-combustion engines. The paper concludes with some general remarks on the change of conductivity of different metals and alloys with the temperature. The conductivity values are in general fixed correct to ± 5 to 15 %, even for very high temperatures; for a few metals this is only true for ordinary temperatures. H. N. A.

147. *Thermal Conductivity of Bismuth in a Transverse Magnetic Field.* **F. A. Ward.** (Phil. Mag. 48. pp. 971–977, Nov., 1924.)—The average diminution of thermal conductivity of bismuth is found to be 3·22 % in a transverse magnetic field of 5370 c.g.s. units. With a field of 6260 c.g.s. units the decrease was of the order of 5 %. A. B. W.

148. *The Thermal Expansion of Crystals of Metallic Bismuth.* **J. K. Roberts.** (Roy. Soc., Proc. 106. pp. 385–399, Oct. 1, 1924.)—An account is given of measurements of the thermal expansion of crystals of metallic bismuth parallel and perpendicular to the vertical axis by comparison with that of crystalline quartz, using an optical lever method which enabled changes of length of 3·4 % 10^{-6} cm., *i.e.* less than one-tenth of a wave-length of green light to be measured. Both expansion coefficients are practically constant from ordinary temperatures up to 240° C. Bismuth melts at about 270° C. The constant expansion coefficients over this range are: Perpendicular to the axis, $12{\cdot}0 \times 10^{-6}$; parallel to the axis, $16{\cdot}2 \times 10^{-6}$; mean, $13{\cdot}4 \times 10^{-6}$. The results are compared with those of Grüneisen and Goens on zinc and cadmium crystals. At present Bi, Zn, and Cd are the only metallic crystals not crystallising in the regular system which have been studied. The bending over of the length-temperature curve as the melting-point is approached indicates dissociation in the solid. The nature of this dissociation and the general properties of solids near their melting-points are discussed. E. G.

149. *The Specific Heat of Superheated Vapours.* **R. Plank.** (Zeits. techn. Physik, 5. 9. pp. 397–404, 1924.)—In this paper the author, after giving the different forms of the expressions which have been given for C_p and which are all empirical, starts with van der Waals' equation and limiting himself to the case in which v is large compared with the critical volume, so that v may be neglected, finds an expression for C_p which is a function of vT^{n+1}. This expression when $n = 3$ is $C_p = C_p^0 + \psi(vT^4)$. C_p^0 denotes the value of C_p where the pressure $= 0$. The form of the function ψ is now deduced by comparing calculated values with observed values. This can be done in the case of water-vapour from the investigations of Knoblauch, Raisch, and Hausen. The equation becomes

$$C_p = C_p^0 + \frac{C_1}{vT^4 - C_2} [C_1 = 8{\cdot}5 \times 10^8,\ C_2 = 26{\cdot}5 \times 10^8].$$

A table is given showing a comparison of the values calculated from this expression and the experimental values. This expression is now tested for the case of saturated and superheated ammonia vapour, by the help of the experimental results of Osborne, Stimson, Sligh, Jr., and Cragoe (Bureau of Standards Refrigerating Eng. 10. 145, 1923) and found to give satisfactory results if $n = 3{\cdot}6$. The author now develops an equation of state by substituting Callendar's expression $v = \frac{RT}{P} - \frac{a_0'}{T^{n+1}}$ for v in the above expression for C_p thus obtaining $C_p = C_p^0 + \frac{C_1 P}{RT^{n+2} - C_3 P}$ where $C_3 = a_0' + C_2$. From this, with the help of the well-known result $\left(\frac{\partial C_p}{\partial P}\right)T = - AT\left(\frac{\partial^2 v}{\partial T^2}\right)P$, the equation of state is obtained, in which the deviation from the gas laws is expressed as a series in powers of P. Finally the author considers the case of very small volume, where the v of van der Waals' equation cannot be neglected. T. B.

150. *Surface Tension, Surface Energy, and the Surface Layer. Part I.* **A. M. Williams.** (Manchester Phil. Soc., Mem. 68. pp. 1-12, 1923-1924.)—The paper commences with some thermodynamical considerations of the subject. Attention is drawn to an addition to the usual expression for the surface energy of a liquid, arising from a possible change of volume in passing from the liquid phase to the surface layer. This correction is concluded to become important only at temperatures near the critical. Thermodynamical inequalities are then deduced giving lower limits to the thickness of the surface layer and to the number of molecules per unit area therein. Applying the relations to a group of liquids, these appear to fall, as usual, into two classes. The relations are further discussed, taking into account considerations other than purely thermodynamical. If the surface layer is monomolecular at ordinary temperatures, it is found not to become two molecules deep till quite close to the critical temperature, when it rapidly increases in depth. H. H. Ho.

151. *Thermodynamical Invariants and the Specific Heat at Absolute Zero.* **W. Jazyna.** (Zeits. f. Physik, 28. 6. pp. 371-372, 1924.)—This is a short mathematical paper in which the author attempts to prove that the specific heat of any body in any transformation in the immediate neighbourhood of absolute zero approaches the value zero. T. B.

152. *The Benedick's Effect in Vacuum.* **E. Rumpf.** (Phys. Zeits. 25. pp. 400–401, Aug. 15, 1924.)—In a previous paper [Abstract 638 (1924)] the author has described an experiment from which he drew the conclusion that the Benedick's effect in copper diminished considerably when the experiment was performed *in vacuo.* The asymmetrical temperature fall was brought about by a heating coil of nichrome wire wound on a mica frame surrounding one of the arms of the cross. It was assumed that the same heating current in this coil would produce the same temperature distribution in the copper whatever the air pressure. Further experiments have shown that such an assumption is untenable and the previous experiment therefore does not establish a diminution of the Benedick's effect *in vacuo.* L. L.

153. *A Small Combustion Bomb and Micro-Calorimeter.* **W. A. Roth, H. Ginsberg** and **R. Lassé.** (Zeits. Elektrochem. 30. pp. 417–420, Sept., 1924. Paper read before the Deut. Bunsen Gesell., Göttingen, 1924.)—In order to determine the heat of combustion of expensive materials, of which only small quantities are available, a small bomb has been constructed which gives good results with from a quarter to one-fifth of the usual quantities employed. The following table permits of a comparison with an ordinary bomb and calorimeter :—

	Ordinary.	New.
Weight of bomb	3000–3400 grammes	614 grammes
Internal volume	About 300 cm.^{3}	21·5 cm.^{3}
Water content	2000–2400 grammes	500 grammes
Water value	2400–2800 grammes	595 grammes

Instead of platinum, in order to reduce expense, the bomb is either made of a special Krupp steel (V2A) or still more cheaply of nickelled bronze or cast steel, with a lining of pure silver coated with silver bromide. If the silver bromide layer is damaged the injured spot is painted with 0·5n hydrobromic acid solution saturated with bromine, the acid being wiped off in a few minutes. This coating enables substances containing a halogen to be burnt in the bomb. The combustion pan is of platinum, but weighs only 2/3 gramme. For details of the construction the original paper should be consulted. Examples of determinations are given; the uncertainty of the results is on the average 0·5 %. H. N. A.

154. *A Calorimeter for Measuring Specific Heats and Heats of Vaporisation of Liquids. The Specific Heat and Heat of Vaporisation of Liquid Ethyl Ether at* 0° *and* 12°. **F. G. Keyes** and **J. A. Beattie.** (Am. Chem. Soc., J. 46. pp. 1753–1760, Aug., 1924.)—A new type of calorimeter for the determination of the specific heats and heats of vaporisation of liquids is described. It can also be used for the determination of the specific heats of compressed gases. This calorimeter can be used over wide ranges of temperature and is especially suited for use in the range under room temperature. The apparatus consists of a silver calorimeter enclosed in a glass vessel, so arranged that the space between can be evacuated when desired. Provision is made for withdrawing known amounts of dry saturated vapour at the temperature of the liquid, and for introducing measured quantities of electrical energy. The temperature of the liquid in the calorimeter is measured by means of a platinum thermometer placed in good thermal contact with it. The heat of vaporisation and specific heat of liquid ethyl ether were determined for the temperatures 0° and 12°, with an accuracy within about 1 %.

Heat of Vaporisation of Ethyl Ether.

Temperature.	Calories per Gramme.
0·1°	90·50
11·8°	88·83

Specific Heat of Liquid Ethyl Ether.

Temperature.	Calories per Gramme per Degree.
1·2°	0·568
13·4°	0·577

E. G.

155. *New Micro-Melting-Point Apparatus.* **J. F. Clevenger.** (Indust. and Engin. Chem. 16. pp. 854–855, Aug., 1924.)—This apparatus consists of an electrical heating device which fits on to the stage of a microscope and permits of the determination of the melting-point of individual crystals. By means of a rheostat the rate of heating may be controlled and any temperature up to 400° C. attained. T. H. P.

156. *I. The Entropy of Gases and the Theory of Quanta. II. The Chemical Constant of Monatomic Gases.* **A. Schidlof.** (Arch. des Sciences, 6. Supplt. pp. 61–67, July–Aug., 1924. Paper read before the Soc. de Physique et d'Histoire Naturelle, Geneva.)—I. In classical mechanics the expression of the probability of the state of a system is independent of the form of the cells of equal probability, according to Liouville's theorem, but this theorem cannot be applied to the quantum theory, where the size of these cells is defined in advance as h^3 where h is Planck's constant. If $q_1q_2q_3$ are the coordinates, and $p_1p_2p_3$ the generalised impulses of a monatomic molecule, we have $h^3 = \int\int\int\int\int\int dp_1dp_2dp_3dq_1dq_2dq_3$. The triple integral $\int\int\int dq_1dq_2dq_3 = \nu$ signifies the volume in which occurs the quantified movement of the molecule. O. Sackur assumes that this volume is $\nu = V/N$ for a gas composed of N molecules contained in a receptacle of capacity V. The choice of volume seems to be arbitrary; there is only one case where there is no doubt as to the volume in which the movement is to be quantified, that is where the receptacle of volume V contains only one molecule which takes successively all the states of movement compatible with the imposed conditions. If V is sufficiently large, the molecule behaves as one of the systems of three degrees of freedom of a canonical distribution of Gibbs, of modulus kT, where $k = R/N$ = gas constant divided by Avogadro's number. This distribution is shown to lead to the equation, $\psi = -kT \log \{V(2\pi kmT)^{3/2}h^3\} + \epsilon_0$, where ψ is the free thermodynamic energy of the molecule. From the thermodynamic formula $S = \partial\psi/\partial T + c$ the equation for the entropy is

$$S = k \log \{V(2\pi kmT)^{3/2}h^3\} + 3k/2 + \text{const.}$$

Further equations are developed which are shown to lead to two conclusions: (*a*) The molecular movement of progression is to be quantified in the interior of the entire volume of the receptacle which contains the gas; (*b*) the idea of the absolute entropy gives rise to some difficulties, which disappear, however, if one completes the expression for the entropy by adding a constant.

II. According to Planck, the thermodynamic equilibrium of a vapour in presence of its condensed phase satisfies the condition $F' - F = p(V - V')$ where F′ is the free energy of the condensed phase, F that of the gaseous phase, and p is the pressure. This leads to $p(V - V') = RT$ where R is the gas constant. If f is the free energy of a molecule in the gaseous state, and f' in the condensed state, and $k = R/N$, we have $f - f' = kT$. From the equations deduced in Part I above it is now shown that, if λ is the latent heat of vaporisation of the molecule, $\log p = -\lambda/kT + \log\{(2\pi m/h^2)^{3/2}(kT)^{5/2}\}$, from which it follows that the chemical constant of a monatomic gas has the value $\log\{(2\pi m/h^2)^{3/2}k^{5/2}\}$. T. B.

157. *Entropy of Condensed Gases.* **A. Eucken** and **F. Fried.** (Zeits. f. Physik, 29. 1. pp. 36–70, 1924.)—As in Abstract 165 (1925), equations are established for the thermodynamic relations for chemical equilibrium in a number of homogeneous and heterogeneous reactions. The integration constant i_k for this thermodynamic equation is obtained as for the integration constant i for vapours. The results are applied to 21 different chemical changes, in some of which gases only are used, and in others partly gas and partly solid substances. The value of i_k is obtained in each of the 21 reactions, but the results are not consistent and the deviations are irregular and not systematic. Thus the Nernst heat relation $i_k = \Sigma i$ is not satisfied. To obtain greater agreement a lower limit for entropy for a substance in the solid state must be accepted. This is definitely the case for hydrogen and probably for a number of other substances. The application of a correction equal to $R \log_e 2$ is examined for a number of cases and the results improved, but not in every case, and it appears that a multiple of $\pm R \log_e 2$ may be required for different gases. R. S. R.

158. *On a Case of Steady Flow of a Gas in Two Dimensions.* **S. Lees.** (Cambridge Phil. Soc., Proc. 22. pp. 350–362, Sept., 1924.)—The problem of finding general types of solution for the steady flow of gases in two dimensions, adiabatically and without friction, does not appear to have received a great deal of attention. Reference is made to the work of Riemann-Weber and Rayleigh [see Abstract 1100 (1916)], the latter having given a general differential equation which must be satisfied by the velocity potential ϕ, but the problem of utilising this equation does not appear easy. In the present paper the assumption is made that the velocity components for steady adiabatic flow of a gas are functions of the density only, and the consequences of this assumption are then discussed. No external forces are supposed to act on the gas. Real solutions are found to be only possible when the velocity of the gas exceeds the velocity of sound at any point. Equations are obtained for the general solution for real steady flows, but the results take a particularly simple form, given in detail, when the arbitrary function ϕ is taken as constant. The paper arose originally from a correspondence on the subject of nozzles. H. H. Ho.

159. *The Quantum Theory of the Monatomic Perfect Gas.* **A. Einstein.** (Preuss. Akad. Wiss. Berlin, Ber. 22. pp. 261–267, 1924.)—A quantum theory of the monatomic perfect gas free from arbitrary assumptions has hitherto not existed. This defect will now be remedied in a forthcoming publication by Bose, upon which the present author has based a derivation of the Planck radiation formula. The phase space of a monatomic molecule with respect to a given three-dimensional volume is divided into cells. If several of such elements are present, the microscopic distribution determines the thermodynamic treatment. The probability of a macroscopically defined state in the Planck sense is equal to the number of different microscopic states by which the macroscopic state can be realised. The entropy of the latter, and therewith the statistical and thermodynamic behaviour of the system, is then determined by the Boltzmann hypothesis. The paper, which is entirely mathematical, considers the question under five sections, *viz.*, § 1. The cells. § 2. State probability and entropy. § 3. Thermodynamic equilibrium. § 4. The classical theory as the limiting case. § 5. The deviation from the gas equation of the classical theory. H. H. Ho.

160. *The Critical Pressure-Ratio for Gases as Affected by Variable Specific Heat.* **W. J. Walker.** (Phil. Mag. 48. pp. 703–707, Oct., 1924.) —In continuation of earlier work [see Abstract 1482 (1922)] the critical pressure-ratio for maximum discharge of a gas with variable specific heat is worked out. It is found to be higher at higher temperatures, and also higher than under the assumption of constant specific heat. Qualitative agreement with recent experiments is pointed out. E. G.

161. *Air Waves of Finite Amplitude.* **W. B. Morton** and **Amy I. Woods.** (Phil. Mag. 48. pp. 866–883, Nov., 1924.)—The conditions under which it is possible for a disturbance of finite amplitude to be propagated through a gas without change of type were examined by the late Lord Rayleigh, who showed that the possibility of the physical existence of the wave is conditional upon the existence of a solution to a certain differential equation. By the graphical method of isoclines the authors examine the solution of this equation more broadly. They further investigate the physical characteristics of the wave in some detail. G. A. S.

162. *Quantising Systems containing Identical Elements.* **E. Fermi.** (N. Cimento, 1. pp. 145–152, May–June, 1924.)—Sommerfeld's rule that where variables can be separated the integrals of phases, $(\int)pdq$, are integral multiples of h gives good results with hydrogen, but is not satisfactory with other elements, even with helium. The author believes this is due to losing sight of the fact that identically similar elements are repeated in the more complex atoms and that the true periodicity is that of recurrence of a similar position; so that the period, instead of involving 2π, may involve, say, $2\pi/3$. On these lines he works out the problem of finding the entropy of a perfect gas, in which Sommerfeld's rule is found to fail if the volume contain more than one molecule; and he obtains satisfactory results for a single gas and for a mixture of two gases. A. D.

163. *Indirect Measurement of the Aqueous Vapour-Pressure of Capillary Systems by the Freezing-Point Depression of Benzene.* **E. M. Crowther**

and **A. N. Puri.** (Roy. Soc., Proc. 106. pp. 232–242, Sept. 1, 1924.)—Tests have been made of an indirect method for measuring aqueous vapour-pressures based on the fact that the freezing-point of benzene is depressed by an amount strictly proportional to the aqueous vapour-pressure of an insoluble material with which it is in equilibrium, provided that surface energy is not one of the factors determining the vapour-pressure of this material. The method proves both rapid and accurate when applied to substances such as sulphuric acid-water mixtures and certain salt hydrates. With capillary systems, such as soil, equilibrium is established more slowly, and the apparent vapour-pressures show a systematic deviation, which is of the same magnitude for soils of widely different types.

By assuming that a fractional part of the water in such cases is held in micropores, and by making allowance for the effects of the changes in surface energy caused by introduction of an additional liquid phase, it is possible to account for the deviation. Satisfactory agreement exists between the observed values of the vapour-pressure and those calculated on the basis of this assumption. T. H. P.

164. *Contribution to the Kinetic Theory of Vaporisation.* **S. C. Bradford.** (Phil. Mag. 48. pp. 936–947, Nov., 1924.)—Modern research on the electrical structure of matter has confirmed the view of van der Waals that molecules are surrounded by fields of force, and attempts have been made to study the properties of solutions in relation to molecular attraction, or cohesion pressure, and motion. The present contribution applies the kinetic theory to obtain a mathematical expression for the vapour-pressure of liquids in the form

$$\rho = 56 \cdot 47 \frac{\mathrm{T}}{\phi \rho^{\frac{1}{3}} \mathrm{A}} \cdot e^{-\frac{3 \cdot 806 \mathrm{SVA}^{\frac{1}{3}}}{\mathrm{T} \delta' \rho}}$$

where T the absolute temperature, ϕ the co-volume, ρ the density, A the degree of association, S the surface tension, V the volume of a gramme molecule, and $\delta' \times 10^8$ the nearest distance of approach of the centre of two molecules of the liquid. Vapour-pressures calculated by means of the formula agree very well with the values observed at given temperatures, and become equal to an atmosphere at the boiling-points of the liquids. It is pointed out in this paper that Edser's formula $\mathrm{S} = \frac{\mathrm{K}\delta}{4}$ may be used to calculate the cohesion of liquids with considerable accuracy. Tabular values of the observed and calculated vapour-pressures of various liquids, including ether, toluene, benzene, acetone, ethyl acetate, pyridine, aniline, alcohol and water are given, together with their molecular constants. [See also Abstract 395 (1923).]

A. W. J.

165. *Constant i of the Thermodynamic Vapour-Pressure Equation for Molecules containing more than one Atom.* **A. Eucken, E. Karwat** and **F. Fried.** (Zeits. f. Physik, 29. 1. pp. 1–35, 1924.)—The general equation for the pressure of a rarefied vapour is stated in terms of the latent heat of condensation, temperature and molecular heat. Corrections are introduced into the equation to make it applicable also at low temperatures and under such conditions that the vapour does not approximate in its behaviour to the ideal gas. The exact relation is then determined of the integration constant, in the thermodynamic vapour-pressure equation, to the entropy constant. The mean error of this constant for the substances H_2, N_2, O_2, Cl_2, I_2, NO, CO, HCl, HBr, HI, CO_2, H_2O, NH_3 and CH_4 is found, the calculations being partly based on recent measurements of the heat capacity of the vapours at low temperatures. The values obtained from these thermal relations agree in the main with results from formulæ for molecular moments of inertia based on optical measurements (band spectra, etc.), yet throughout the deviations are greater than the calculated mean errors. For some of the vapours the optical value is the greater, for others it is less, and at present no regularity in the deviations has been noted. R. S. R.

166. *On the Corresponding Temperatures of Solid Bodies.* **H. Lafuma.** (Comptes Rendus, 179. pp. 684–686, Oct. 13, 1924.)—In a recent paper Brodsky [see Abstract 2994 (1924)] has shown that the empirical result of Michaud may be deduced from the modern theory of specific heat. The present author claims priority for this result in a 1923 publication in the " Bulletin Scientifique des Étudiants de Paris," and now indicates several points of disagreement with Brodsky's conclusions. The note is mainly mathematical. H. H. Ho.

167. *The van der Waals Equation of State and the Liquid State of Aggregation. I.* **J. Berger.** (Zeits. phys. Chem. 111. pp. 129–156, July 15, 1924.)—Making use of known data for a number of liquids, the author calculates the values of the constants in the van der Waals equation by several methods. Starting with the general equation of state, he derives a " heat-expansion constant " in terms of the coefficient of expansion and the temperature, the value of which is approximately confirmed by the experimental data. He then shows that the value of b and a obtained from the volumes at the boiling-points are different from those calculated from the critical data of the liquids. He considers the theorem of corresponding states and the ideal van der Waals substance, and formulates the " reduced " equation of state. With suitable values of the constants b and c (heat-expansion constant) he compares the equations for heat of vaporisation with the experimental figures, and shows that, except for association, they agree with Stephan formula. W. C. S. P.

168. *Quasi-analytical Solutions of the Equation of Heat.* **E. Holmgren.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 18. 9. pp. 1–9, 1924. In French.)—Solutions $z(x, y)$ are given of the heat equation $\partial^2 z/\partial x^2 - \partial z/\partial y = 0$. This is a purely mathematical paper. T. B.

169. *The Method of Logarithmic Isochromates.* **H. Schmidt.** (Zeits. f. Physik, 29. 2. pp. 81–85, 1924.)—Denoting by $E_{K\lambda}$ the monochromatic radiation intensity of a comparison source (not black) with an arbitrary absorptive power A_λ at the constant temperature T_K, and denoting by $E_{0\lambda}$ the radiation intensity of a black body at the variable temperature T, then the black logarithmic isochromate is given by

$$\log (E_{0\lambda}/E_{K\lambda}) = C_2/\lambda T_K - C_2/\lambda T + \log (1/A_\lambda) \ldots\ldots\ldots (1)$$

The coordinates of the point of intersection of the black isochromates for λ_1 and λ_2 are

$$\log (E_{0\lambda}/E_{K\lambda}) = (\lambda_2 \log A_{\lambda_2} - \lambda_1 \log A_{\lambda_1})/(\lambda_1 - \lambda_2) \quad \ldots\ldots(2)$$

$$1/T = (\lambda_1\lambda_2/C_2) \,.\, (\log A_{\lambda_1} - \log A_{\lambda_2})/(\lambda_1 - \lambda_2) + 1/T_K \ldots\ldots(3)$$

For a grey isochromate (A_0 = constant), (2) becomes

$$\log (E_{0\lambda}/E_{K\lambda}) = (\lambda_2 \log A_{\lambda_2} - \lambda_1 \log A_{\lambda_1})/(\lambda_1 - \lambda_2) + \log A_0$$

while (3) remains unaltered.

If the isochromates in a given region of the spectrum are to intersect in a common point, the coordinates of this point must be independent of λ. This will be the case when $\log (A_{\lambda_1}/A_{\lambda_2}) = \pm\, b(\lambda_1 - \lambda_2)/\lambda_1\lambda_2$, *i.e.* when

$$A_\lambda = a \,.\, e^{\pm b/\lambda} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

By combining (3) and (4) we see the meaning of the abscissa of the common point of intersection, *i.e.*

$$1/T = \pm\, b/C_2 + 1/T_K \ldots\ldots\ldots\ldots\ldots\ldots(5)$$

The ordinate is for a black isochromate (A = constant) given by $\log (E_{0\lambda}/E_{K\lambda}) = \log (1/A)$, and for a grey isochromate (A_0 = constant), $\log (E_{0\lambda}/E_{K\lambda}) = \log (A_0/A)$. When the absorptive power is given by (4), we have $\log (E_{0\lambda}/E_{K\lambda}) = \log (1/A)$ and $\log (E_{0\lambda}/E_{K\lambda}) = A_0/a$.

Equation (5) shows that if we know T_K we can determine the course of the absorptive power. According to the manner in which the absorptive power depends on the wave-length, we have $T \gtreqless T_K$. If the absorptive power is constant $T = T_K$. For most bodies the absorptive power decreases with increasing wave-length and $T > T_K$. Since $\log (E_{0\lambda}/E_{K\lambda})$ is constant for the point of intersection of the isochromates, it is the criterion that the colour-temperature of the radiation of the comparison-source should be independent of the wave-length. E. Benedict has deduced from the common point of intersection of the logarithmic isochromates for the positive crater of the carbon arc that the absorptive power of carbon is constant, and that the temperature is 4200° abs. The same value for the temperature can be obtained from Wien's displacement law of the maximum intensity, but the agreement in the two results is easily understood, and the temperature of the radiator under investigation is left undetermined. T. B.

SOUND.

170. *Vibrations in Organ-Pipes of Unusual Shapes.* **J. A. Aldis.** (Nature, 114. pp. 309–310, Aug. 30, 1924.)—In the endeavour to design a pedal stop for an organ suitable for home use, the author hit upon what is termed the *Bicylindron*. This is a small mouthpiece tube of radius r and length h joined by a flange to a second stopped tube of radius R and length h. Then it is found that $\tan mh = \pm \frac{r}{R}$, where $ml = \pi$, gives the length l of the tone as estimated by organists, *i.e.* bass C = 8 ft. tone, tenor C = 4 ft. tone, etc. If the ratio r/R is made exactly equal to $\tan (\pi/n)$, where n is any integer, then the sequence of possible frequencies is 1, $n - 1$, $n + 1$, $2n - 1$, $2n + 1$, $3n - 1$, $3n + 1$, etc. For pedal notes the best values of n are 5, 7 or 9; these will give octave harmonics. Thus for $n = 5$ the fundamental and overtones have frequencies as 1, 4, 6, 9, 11, 14, 16, etc., which should give a far better quality than the ordinary stopped diapason. E. H. B.

171. *Israj, an Indian Stringed Instrument.* **D. B. Deodhar.** (Phys. Soc., Proc. 36. pp. 379–382, Aug., 1924.)—The remarkable Indian stringed instrument called Israj is here described. In this instrument all the overtones, which would have been absent according to the Young-Helmholtz law, are brought into prominence by a special form of bridge. The upper portion of the belly is covered by a light skin membrane, and an extra chamois-leather ribbon is stretched along a diameter perpendicular to the strings. The mechanical impulses of the bridge are carried to the membrane, which is thus energised and emits several harmonics. The chamois-leather makes a gradual distribution of impulses from the centre outwards. On this instrument melodies are played by bowing the main string (usually of steel). Tones of different pitches are elicited by fingering the frets which are adjusted upon the resounding wooden body. There are three additional brass strings on the left side of the main string, tuned to octaves from the grand C up. The main string is tuned to a major fourth with the adjacent wires. Besides these four wires there are thirteen additional brass strings, making an equal tone temperament scale, which produce a considerable resonance effect. Israj is like a Sitar in that it is a fretted instrument, and it is like a violin in that it is excited by bowing. It is claimed that the tone quality is richer and fuller than that of a European violin. The paper includes three diagrams and a view of the whole instrument. E. H. B.

172. *Resonance Frequencies of Compound Resonators.* **E. T. Paris.** (Phil. Mag. 48. pp. 769–799, Nov., 1924.)—Theoretical expressions are developed by means of which the resonance frequencies of several types of compound resonator employed in acoustical instruments can be calculated by the use of graphical methods. The types of resonator discussed are: (1) The Boys double resonator, consisting of a Helmholtz resonator combined with a stopped pipe. The theory previously given is extended to the case when the Helmholtz resonator is at some distance from the stopped end of the pipe, and the relation between the resonance frequencies and the distance of the Helmholtz resonator from the stopped end is discussed. This type of resonator is used in the Rayleigh disc and hot-wire instruments. (2) A compound resonator made from two Helmholtz resonators and a stopped pipe. This kind of resonator is used in hot-wire microphones which are to be employed with the "bridge" method of measurement or which are to be sensitive throughout two distinct ranges of frequency. (3) A combination of Helmholtz resonator and conical horn used for hot-wire microphones, and analogous to the diaphragm and horn combination in the phonodeik and similar instruments. Experiments are described which show a satisfactory agreement with the theoretical results. G. A. S.

173. *Self-exciting Phenomena in Systems with disturbed Superposition.* **K. Heegner.** (Zeits. f. Physik, 29. 2. pp. 91–109, 1924.)—The theory of the self-exciting phenomena, which may be observed by forced vibrations in coupled systems so soon as they contain a non-linear term, is here developed. The experiments begin with the special case in which the self-excited vibration stands in rational relation to the frequency of the exciter, and are then extended to other cases in which two frequencies occur connected in a linear way with the given frequency. A number of experiments are described and their oscillograms reproduced. [See Abstract 1628 (1920).] E. H. B.

174. *Relative Temperature Measurements in Stationary Sound Waves.* **J. Friese** and **E. Waetzmann.** (Zeits. f. Physik, 29. 2. pp. 110–114, 1924.)—In the case of stationary sound waves in a metre-long tube (as for Kundt's dust figures), produced by a telephone giving a frequency of 800 per sec. the temperature at the nodes and loops is ascertained by a resistance thermometer and valve amplifier. The wire of the thermometer is 4 μ thick and 18 mm. long, and is carried at the end of a smaller glass tube which can slide into the main or sound tube. Graphs of the results are given. E. H. B.

175. *Loudness of a Complex Sound.* **H. Fletcher** and **J. C. Steinberg.** (Phys. Rev. 24. pp. 306–317, Sept., 1924.)—Two complex sounds are studied, one with a continuous energy frequency spectrum corresponding to connected speech, the other a test tone having discrete frequency components. By means of filters the energy is removed from all frequencies either above or below a certain limit, and the resulting decrease in loudness is measured by attenuating the original sound without distortion until it is equal in loudness to the filtered sound. Taking the average value for six observers, this decrease is found to depend on the absolute values of the loudness. For a loudness of 22 units (*i.e.* an intensity = 10^{22} × the threshold intensity) each frequency region contributes to loudness in proportion to the energy in that region weighted according to the threshold energy for that frequency. For a loudness above 30 units this is no longer true because of the non-linear character of the response of the ear. By assuming that each region contributes in proportion to a fractional power of the weighted energy of that region, values of the total loudness in agreement with observation are obtained if suitable values are taken for the index of the fractional power, decreasing to 1/31 as the loudness increases to 100 units. G. A. S.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

176. *Advanced Potentials and Atomic Models.* **L. Page.** (Phys. Rev. 24. pp. 296–305, Sept., 1924.)—As a means of reconciling electromagnetic theory with radiationless orbits, Nordström has suggested the possibility of the fields of electrons being half-retarded and half-advanced in place of being wholly retarded, as usually assumed [see Abstract 419 (1920)]. On the emission theory this would mean that each electron is the focus of converging streams of moving elements which pass through it undeflected. The author's objective is to make a more detailed examination of such fields, and in pursuit thereof (1) advanced fields and fields which are half-retarded and half-advanced are interpreted from the view-point of the emission theory; (2) simple one-way series for the simultaneous retarded and advanced potentials and field strengths of a point charge are deduced, and it is shown that, if the field of the electron be half-retarded and half-advanced, all terms in its dynamical equation which involve odd time derivatives of the acceleration vanish, so that there are no damping reactions, while even terms, such as the mass reaction, retain their accustomed value, whence it follows that an electron of this type would be capable of describing a periodic orbit such as is postulated in the Bohr theory; (3) while the radiation emitted during a full period vanishes, since the converging waves which constitute the advanced portion of the field bring the electron as much energy as it loses by the emission of diverging retarded waves, nevertheless fluctuation of energy would take place during each period, and the converging and diverging waves should combine to form standing waves. And it would be anticipated that these waves would cause a second electron over which they might pass to oscillate, and it would be expected that such oscillations would lead to detectable effects. This is not the case which constitutes a serious objection to the theory. Were it overcome, the question as to how radiation or absorption may occur during transitions from one stationary orbit to another might admit of solution. The analysis suggests that the retarded and advanced portions of the electron charge might not remain coincident during a transition, in which case it shows that if these two portions of the charge describe similar orbits of different sizes about the nucleus with the same frequency, emission exceeds or falls below absorption according as the retarded or the advanced portion of the charge describes the orbit of greater size. G. W. DE T.

177. *A Suggestion as to the Structure of Light.* **J. J. Thomson.** (Phil. Mag. 48. pp. 737–746, Oct., 1924.)—The paper commences with a statement of the contradiction between the evidence as to the nature of light afforded by its optical properties on the one side, and its electrical ones on the other. There has perhaps never been a case where agreement between theoretical prediction and experiment is so complete as in the undulatory theory of light—a theory which supposes that the disturbance constituting light is represented by a continuous function of the time and spatial coordinates, the energy being distributed continuously throughout the beam. From the electrical properties of light, however, everything points to great concentration of energy into discrete centres, and the front of a wave, instead of being, as it were, uniformly illuminated, is represented by a series of bright specks on a dark ground. These electrical properties point just as clearly to something resembling the Newtonian corpuscular theory as the optical ones do to the undulatory theory. The author now describes at great length and clarity a mental picture, based on the idea of tubes of electric force, which he has personally found useful for reconciling the optics with the electricity. Briefly stated, light energy is imagined to get free from a tube of force as a closed ring, while the death of the latter means either the birth of a high-speed electron or the emission of a unit of characteristic radiation. This is in exact accordance with Barkla's observation that when a beam of Röntgen rays is wholly absorbed in a gas without the emission of characteristic radiation, the number of high-speed electrons produced is independent of the kind of gas and its physical condition. These rings are the centres in which the energy of light or Röntgen rays is concentrated. Any transference of energy from light to matter involves the destruction of these rings; thus the amount of energy transferred from a beam of monochromatic light or homogeneous Röntgen radiation must be an integral multiple of a unit. The energy of a ring is calculated, and for geometrically similar rings the energies are found to be inversely proportional to the linear dimensions. The waves round the ring are next considered, and the results utilised for the explanation of interference and analogous phenomena. Separate sections are devoted to the problems of absorption of light and resonance. On the view taken, the production of a ring is due to a deformation in the tubes of electric force produced by a rapid diminution in the potential energy. It is possible, however, to imagine electric waves without a ring; thus, if an electron is moved with uniform velocity round the circumference of a circle with a positive charge at its centre, electric waves, whose frequency is that of the moving electron, will be generated, but will not necessarily be accompanied by a ring. H. H. Ho.

178. *Anomaly in Frictional Electricity.* **A. O. Rankine.** (Phys. Soc., Proc. 36. p. 430. Aug., 1924.)—An unpolished ebonite rod always becomes negatively charged when rubbed with flannel, but a similar polished rod can be got into such a state by prolonged beating with specially prepared flannel that it becomes negative when lightly rubbed by a piece of the prepared flannel, but positive when vigorously rubbed. Yet when the polished and the unpolished rods are rubbed together it is the *unpolished* that becomes positive. No explanation is offered. G. A. S.

179. *Variable Mica Condenser.* **H. G. Dorsey.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 353–354, Sept., 1924.)—Describes a type of variable mica condenser consisting of a number of plates of copper foil and phosphor-bronze alternated with sheets of mica between, the copper projecting at one end and the bronze at the other; the condenser, when assembled, is clamped between aluminium castings. The copper plates are soldered together to form one terminal. The bronze plates are arranged so that a screw working through the top clamping plate will, when screwed forward, connect two or more plates in parallel, and so alter the capacity by successive steps. The clamping plates, screw and phosphor-bronze plates form the other terminal. A photograph of the complete condenser is given, together with dimensions for two sizes of condenser having maximum values of 0·018 and 0·1 μF. respectively. The con-

condensers are used for tuning resonating circuits where it is not essential to know the exact capacity and where step-by-step changes are suitable. The capacity is constant at a given setting, and can be easily measured.

B. H.

180. *Measurement of Electric Potential.* **A. Wigand** and **T. Schlomka.** (Ann. d. Physik, 75. 3. pp. 279–325, Sept., 1924.)—The object of the researches described was to make the aeroplane available for the measurement of the atmospheric fall of potential and at the same time to solve the problem of the electric self-charging of aeroplanes and the removal of this charge. Descriptions are given of measurements by means of motor-driven aeroplanes, of the electrometer and collectors, and the attachment of these latter to the aeroplane. Investigations are also described on the self-charging of aeroplane motors. Especially the researches of Dieckmann and Linke are considered and those of Fuhrmann. The result of the work is to show the feasibility of the measurement of electric potentials by aeroplanes and airships. Measurements made with aeroplanes in flight prove, in agreement with earlier laboratory experiments, that there is a considerable positive self-charging of the motor and negative charge of the expelled gases. The height of this charge of the aeroplane depends upon the efficiency of the motor. Removal of the aeroplane charge is possible by compensation by the same means as are used in the technical processes during motion of the aeroplane. For undisturbed measurement of the atmospheric fall of potential, on the other hand, the aeroplane, on account of its self-charging, is not usually suitable.

J. J. S.

181. *Theory of Ball Lightning.* **E. Mathias.** (Comptes Rendus, 179. pp. 550–553, Sept. 22, 1924.)—Deals with the objections raised to the theory previously propounded by the author, *viz.* that the passage of a lightning flash through the air transforms this into a "condensed air" of very high temperature and of density slightly higher than that of ordinary air. The surface of discontinuity which separates the two gases is supposed to be in a state of tension, and the condensed air, being an endothermic substance, explodes spontaneously when the temperature has fallen sufficiently.

J. W. T. W.

DISCHARGE AND OSCILLATIONS.

182. *Discharges from Points in Gases, with Special Regard to so-called Dark Discharges.* **J. Zeleny.** (Phys. Rev. 24. pp. 255–271, Sept., 1924.)—The literature on the discharge of electricity through gases contains frequent reference to a non-luminous form of discharge—a so-called dark discharge. Faraday refers to dark discharges, but apparently he usually means by dark discharges dark spaces in otherwise luminous discharges, such as the dark space that now bears his name. Some evidence that a minute non-luminous discharge precedes the passage of a spark, even though it could not be detected by means of an electroscope, was obtained by Warburg. The dark discharge is generally said to be the first of a number of forms which discharges take as the current between the electrodes is gradually increased. The present research is undertaken to determine whether dark discharges are really distinct forms of discharge and whether they are altogether devoid of light. Discharges from points are chosen because the discharge is so concentrated at a point that luminosity should most easily be seen, if present. Observations are made through

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a microscope, and show (1) that the light does not disappear suddenly, but fades out gradually as the current is reduced, and (2) that there is no abrupt change of current with voltage in this initial region of the discharge. The limiting current to give a visible glow increased from 2×10^{-9} to 8×10^{-8} amps. for negative discharges in air at atmospheric pressure as the diameter of the point is increased from 0·01 to 1·14 mm. For positive discharges the limiting current is roughly twice as large. With pure HCl vapour, higher voltage is necessary, but the behaviour is similar. Initial stages in discharges from points in air are studied by increasing, by means of alpha-rays, the ions normally present until the current due to them alone is measurable on a galvanometer. Typical results are as follows: In the case of a certain point, as the voltage is increased, the positive current begins to increase gradually at about 2000 volts below the normal starting voltage, 5000 volts, whereas the negative current is constant to over 4500 volts, and then increased very suddenly. This behaviour is explained in terms of known properties of the ions. With luminous effects of point discharges in air and in helium microphotographs are reproduced showing the thin glow covering the surface of the positive electrode and the fan-shaped brush spreading from a small luminous area of the negative electrode. Changes in the luminous effects with changes of pressure are noted. [See also Abstract 201 (1923).] A. E. G.

183. *The Measurement of Critical Potentials of Gases.* **E. G. Dymond.** (Cambridge Phil. Soc., Proc. 22. pp. 405–408, Sept., 1924.)—In all methods of measuring excitation and ionisation potentials which are in common use the current-voltage characteristic curves of the apparatus are plotted. In the absence of gas these curves are smooth, but on the admission of gas at a suitable pressure sharp upward bends occur at definite voltages, which are interpreted as the critical potentials of the gas. In a variation by Franck and Hertz [see Abstract 1583 (1914)], the so-called inelastic impact method, these bends are downwards, the critical points being represented by maxima. Difficulties arise in the exact fixation of these points, because they are not sudden but rather gradual changes in the current, and it is customary to extrapolate the upper and lower portions of the curve (which are to a first approximation linear) until they meet and call this the critical point. This proceeding is a little arbitrary, and it seemed desirable, in order to heighten the accuracy of measurement, to increase the sharpness of the bends. A possible method of doing this is to plot the differential of the current-voltage curve instead of the curve itself, preferably arranging the apparatus to record this curve directly. A simple device for doing this is described. The gas chosen to test the method is helium, both on account of its ease of purification and of the positive nature of the results hitherto obtained. It is purified in the usual manner before use by standing over charcoal cooled in liquid air. The results obtained are essentially preliminary, and indicate the capabilities of the method rather than contributing any fresh data on the critical potentials of helium. The problem of determining the exact value of the excitation potential and of forming an estimate of the form of the probability function of inelastic collision, taking this velocity distribution into account, is at present under investigation. A. E. G.

184. *Kathode Fall, Current Strength, and Thickness of Fall Space of the Glow Discharge in Mixtures of Gases which do not React Chemically.*

A. Günther-Schulze. (Zeits. f. Physik, 28. 3-4. pp. 129–134, 1924.)—The author has previously published [see Abstract 2475 (1923)] some results obtained in experiments on the normal kathode fall in gas mixtures. In some cases there was satisfactory agreement between calculated and experimental results when the gases did not chemically react on one another, while with chemical reactions the measured curve of the kathode fall shows a characteristic hump over the calculated curve. The height of the hump enables a quantitative relation of the intensity of the chemical reaction between the gases to be established. In the present paper the normal current density and the normal fall space thickness with 1 mm. pressure, as well as the normal kathode fall in the following mixtures of gases, is dealt with: He-H, He-Ne, Ar-He, Ar-H, Ne-H, Ne-Ar, N-H, and the results are given in both tabular and graphical form. A. E. G.

185. *Calculation of Successive Ionisation Potentials.* **D. R. Hartree.** (Cambridge Phil. Soc., Proc. 22. pp. 464–474, Sept., 1924.)—Assumptions are made as to the quantum numbers of the electrons successively captured by an atom. Relations are then deduced between the corresponding terms for different atoms of the same electronic structure and four methods are developed applicable to cases where (1) the orbit is circular and lies well within the core; (2) the orbit is not circular and lies partly in a field which is similar to that from a point charge; (3) a more approximate method for a similar case; and (4) non-circular orbits which lie wholly within the core. Examples of the application of these methods and complete tables of the calculated successive ionisation potentials of oxygen, iron, and silver are given. Attention is drawn to the great difference between the value of the X-ray excitation potential of an electron and the ionisation potential of the same electron when it is the series electron of the atom. A. Wh.

186. *A Simple Kinetic Derivation of the Ionisation and Vapour Pressure Equation.* **R. Becker.** (Zeits. f. Physik, 28. 3-4. pp. 256–260, 1924.)—The method of derivation depends on the relations formulated by the author in a previous paper and by Fowler [Abstract 1257 (1924)]. These assume that only the combination processes in which emission of radiation takes place are in equilibrium with the ionisations connected with absorption of radiation, so that, for example, the probability that a certain bound electron will be thrown out in time, dt, with absorption of radiation, does not depend on whether there is at the same time a probability of ionisation due to collision or not. In a similar manner, in vaporisation, the probability that an atom of the solid body vaporises, making use of the heat contained in the body, must be independent of the presence of vapour atoms, although vaporisation processes may result from their impact. This makes it possible to deal with ionisation and vaporisation by similar mathematical methods. For the mathematical treatment the original paper should be consulted. H. N. A.

187. *The Statistical Theory of Dissociation and Ionisation by Collision, with Applications to the Capture and Loss of Electrons by α-Particles.* **R. H. Fowler.** (Cambridge Phil. Soc., Proc. 22. pp. 253–272, Sept., 1924.)—In two recent papers [see Abstracts 1200 and 1257 (1924)] the statistical theory of collisions of electrons with atoms has been considered and applied to explain the observed features of the capture and loss of electrons by α-particles. The basis of that discussion can, however, be improved. Firstly, interactions with the core of any atom entered by the α-particle were explicitly ignored. Such interactions—or rather interactions with the general intra-atomic field as distinct from individual electrons—might be expected to be (and are) important, and it has been found possible to include them in this paper. Secondly, the frequency laws for the processes concerned were based on the classical Thomson-Bohr theory of ionisation by collision. This theory does not completely reproduce experimental facts at α-particle velocities, and a less restrictive form can be given to the frequency laws, which appears to be in accord with all the known facts. The application to the capture and loss of electrons by α-particles proves to be unaffected. In order to discuss the frequency relations for interactions between α-particles and the general field of an atom, the general frequency relation for three-body encounters in a gas which lead to dissociation or recombination is determined. This is an extension of previous work, in that the bodies concerned may all be of comparable masses. The deduction of this relation is based on the principle of detailed balancing of individual processes. This hypothesis, which is wider than that used in the papers quoted, seems likely to prove of general validity. It has already been employed in a similar manner in discussing radiative processes. The evidence is summarised from the range, ionisation and δ-ray distributions of α- and β-particles in order to specify the most probable form of the frequency coefficient for ionisation of a definite type—that is, the production of a δ-ray of given velocity from a given level in a given atom by an α- or β-particle of given velocity. A detailed discussion is given of the nature of the general field inside an atom from the point of view of its effectiveness in causing loss or capture. A. E. G.

188. *The Mobility in Air of Ions produced in Another Gas.* **G. C. Grindley and A. M. Tyndall.** (Phil. Mag. 48. pp. 711–719, Oct., 1924.)—While many determinations of the mobility of gaseous ions have been made with a view to elucidating their nature, there is by no means unanimous agreement on the conclusions to be drawn from the results. Among some of the more interesting experiments may be classed those which deal with the mobility of ions formed in one gas and measured in another. Four independent investigations have been made by Rutherford, Franck, Blanc, and Wellisch, and the conclusion has been reached that the ion acquires a mobility which is independent of the gas in which it was formed, and cannot be distinguished from an ion formed directly in the gas in which the measurements are made. The work of previous experimenters is briefly discussed. A description, with diagram, of the apparatus now used is given. Experiments are carried out in gases lighter than air—*viz.* hydrogen and ammonia—and also in CO_2, ether, and chloroform. In all cases there is agreement in the position of the voltages at the peaks for air and the gas in question to under 1 %; that is to say, there is no sensible difference between the mobility of ions produced in air and that of ions produced in another gas or vapour and measured in air. This result agrees with the previous conclusion of Wellisch and others. But the agreement is probably more accurate, and, moreover, extends to other ionised gases and vapour, in particular to hydrogen and ammonia, which are lighter than air. It is pointed out that if all the results are grouped together, the value obtained for the ratio of the mobilities of negative and positive ions is very close to 1·50. This agrees more closely with the recent values of Loeb and of Wellisch than with earlier results. A. E. G.

189. *Spark Potential and Kathode Fall.* **H. Stücklen.** (Phys. Zeits. 25. pp. 401–416, Aug. 15, 1924.)—This paper contains a survey of the subject, and the following are among the points dealt with: A consideration of definitions of the terms; the essential differences between the kathode fall and the spark potential; the connection between the kathode fall and atomic weight; the effect of ultra-violet light, X-rays, or γ-rays; the influence of slight impurities upon the generation of the spark; a theoretical investigation of the phenomena of the glow discharge. A. E. G.

190. *The Production and Investigation of Kathode-Rays having Moderate Velocities.* **A. Becker.** (Ann. d. Physik, 75. 4. pp. 435–447, Oct., 1924.) —The author discusses the work of Eisenhut [Diss. Heidelberg, May, 1921] relating to the production of homogeneous kathode rays having moderate velocities by the use of a discharge tube or incandescent kathode actuated by an induction coil or influence machine. The degree of homogeneity obtained in the several cases is referred to. J. S. G. T.

191. *Arc Lights with Non-glowing Kathode.* **A. Günther-Schulze.** (Zeits. f. Physik, 28. 6. pp. 325–328, 1924.)—This paper is in the main a criticism of work on the same subject by H. Stolt, who succeeded in generating an arc light between a fixed anode and a rotating brass (or better still a copper) kathode. Apparently a kathode spot was not visible. The rotating disc could be touched with the finger at a point where the kathode discharge surface had been 1/100 sec. previously. From these experiments Stolt concluded that a white-glowing kathode (or better kathode spot) is not a necessary condition for the arc light. The present paper raises objections to this conclusion, and it is contended that, on account of its extreme smallness, the kathode spot could become completely cool in the time stated. Further, the fact that no kathode spot was seen could be explained firstly by the great brightness of the arc light; secondly, by the small magnitude of the kathode spot; and thirdly, by its evident constant to-and-fro movement. A. E. G.

192. *The Abnormal Low-Voltage Arc.* **C. Eckart** and **K. T. Compton.** (Phys. Rev. 24. pp. 97–112, Aug., 1924.)—In a recent paper [Abstract 2828 (1924)] the authors have suggested an explanation of abnormal low-voltage arcs. In the present paper experiments on oscillating and stable stages of low-voltage arcs in pure helium are described. Measurements with a peak voltmeter, confirmed by photographs with a Braun oscillograph, show that with resistance in the circuit the arc goes through five stages as the current is increased from 0 to 1 amp. for the tube studied: (*a*) voltage stable above the ionising potential, 25·4; (*b*) voltage oscillating from above 25·4 to below the lowest radiating potential, 19·8; (*c*) voltage stable at practically 19·8; (*d*) voltage oscillating from between 20 and 24 to below 19; (*e*) voltage stable above 19·8. The oscillating stages are eliminated by reducing the external resistance to a low value. These phenomena are given a semi-quantitative theoretical explanation on the basis of a negative space charge around the filament for stages *a*, *b*, *c*, and a positive space charge for stages *d*, *e*, and of the probabilities of excitation and ionisation by electron impacts at different voltage. Spectroscopic observations show lines 7065, 6678, 5876, and 5016 are relatively weak during stage *c* and increased in intensity with current in stages *d*, *e*. Arcs can be maintained, using a hot kathode, with an applied voltage less than the minimum critical potential in He and Hg, but not in H_2 and N_2. Such abnormal arcs are found to be oscillating, the maximum voltage in a cycle always exceeding a critical potential. The arc is maintained momentarily at a lower voltage by ionisation of atoms previously excited at a higher voltage, but not in the case of gases such as H_2 and N_2, which do not exist in a metastable excited state, and are not ionised by cumulative action. More recent work shows that with very intense ionisation abnormal arcs may be maintained without oscillations because of the negative potential gradient from the anode to the boundary of the kathode drop. A. E. G.

193. *Temperature of Positive Crater.* **M. Pierucci.** (N. Cimento, 1. pp. 227–241, July–Aug.–Sept., 1924.)—An investigation into the behaviour of forced arcs. The temperature of the crater is in general not constant, but rises with the current density per unit of area, especially at the centre of the crater. In arcs with massive carbons Lummer's results are confirmed; that is, the temperature is almost constant, while it is lower than with forced arcs. The temperature of the aerial part of a forced arc is very high in comparison with that of the same in an ordinary arc. Method: photo-spectrographic; considerable experimental difficulties encountered and discussed. A. D.

194. *Low-Voltage Glows in Hydrogen.* **G. Stead and B. Trevelyan.** (Phil. Mag. 48. pp. 978–1006, Nov., 1924.)—The type of discharge tube employed in the investigation described shows peculiarities not found in the more usual forms of two- and three-electrode thermionic tubes [see Abstract 75 (1923)]. The essential features are (1) the use of a very open grid close to the filament, (2) the absence of an anode, and (3) the large volume on the side of the grid remote from the filament. Under these conditions a large emission can take place from the filament when the p.d. between grid and filament is low, and a considerable proportion of the emitted electrons passes through the grid into the space beyond, giving rise to intense ionisation in a large volume of gas. The present investigation is concerned chiefly with hydrogen. The results obtained appear to indicate (1) some kind of action between hydrogen and a glowing tungsten filament; (2) the formation in the discharge tube of a substance which shows no evidence of ionisation below 40–50 volts, whereas ordinary hydrogen in the same tube ionises at 20–27 volts; (3) the formation of some compound—possibly identical with (1)—which is condensable in liquid air, but unstable at ordinary temperatures. A. B. W.

195. *Thermionic Currents in Electric Lamps.* **P. Selényi.** (Zeits. techn. Physik, 5. 9. pp. 412–418, 1924.)—In an electric lamp a small portion of the current measured by an ammeter in series is carried by the electron stream passing from one leg of the filament to the other. This can be shown by surrounding the lamp with a coil capable of generating a magnetic field of several hundred gauss. The axes of the coil and lamp are coincident. When the current through the coil is switched on there is a small but definite decrease of the current through the lamp, the decrease with an ordinary lamp being a few tenths of a milliampere. Measurements were made on lamps designed for different voltages. In all cases, as was to be expected, the thermionic current was found to increase rapidly with the voltage applied to the lamp under test. Other experiments showed the electron stream to be influenced by electrostatic fields. Hence the effects are similar to those taking place in a triode, the negative end of the filament representing the hot kathode, the positive end the anode, and the wall of the bulb taking the place of the (insulated) grid. A. W.

196. *The Striated Discharge in Mercury-Vapour.* **W. H. McCurdy.** (Phil. Mag. 48. pp. 898–917, Nov., 1924.)—In this investigation, the negative glow, Faraday dark space, and positive column are specially considered. The theory is advanced that the striations which occur in the positive column of the discharge in a monatomic gas under low pressure are due to the presence of impurities; and also that the current in the positive column of the discharge is due to the motion of electrons under the influence of the electric field, while that in the Faraday dark space and the negative glow is due to diffusion of electrons and positive ions produced in the negative glow by the fast electrons from the Crookes dark space. The experimental results confirm the theories advanced in the following important respects: (1) The potential distribution in the discharge satisfies the theory as regards the distribution of space-charge. (2) The concentration of the electrons is found to be a maximum near the kathode side of the striations. Also that of the positive ions, but the variation in the case is not so marked. Further, it is found that the corrections that must be applied to the determination of potential in the discharge by the old exploding electrode method vary from point to point in the striations, and are a maximum near the kathode side of the striation. (3) A reverse field may exist in part of the negative glow, but the concentration gradient of the electrons in the negative glow and Faraday dark space is found to be amply sufficient to account, by diffusion, for the currents observed in the discharge. A. E. G.

197. *Reflection of Electromagnetic Waves at Hertzian Lattices.* **W. Arkadiew.** (Ann. d. Physik, 75. 4. pp. 426–434, Oct., 1924.)—The paper commences with a discussion of the Gans theory of the Hertzian lattice for the investigation of the ferromagnetic properties of metals for rapid electrical oscillations. Following this the experimental results for unmagnetised wires are communicated, these having been obtained by an investigation of the reflective power of narrow lattices from four wires of 49 cm. length. The data compare very satisfactorily with the theoretical values. H. H. Ho.

198. *Irregularities of the Propagation of Short Waves.* **P. Lardry.** (Onde Élec. 3. pp. 449–466, Sept., and pp. 502–510, Oct., 1924.)—Since the first experiments of Marconi it has been known that short waves (200 to 600 metres) are propagated better by night than by day. As the result of the present investigation, it is concluded that during the day reception is more powerful in summer than in winter; there are very sensible variations, but never quite reach the point of extinction. At the moment of sunset the enfeebling reaches extinction. Shortly after sunset there is a great increase of intensity, with very strong and very rapid oscillations; it is pointed out that the relative variations appear equal by day and by night. The fading by night or enfeebling by day of long duration coincide always with the passage of a line of squalls above the antenna of reception. A wave being always complex, the variations upon the harmonics seem to be in advance upon the variations of the fundamental. It is suggested that the only hypothesis to explain this is that of the layer of Heaviside. This hypothesis is discussed at some length, and it is pointed out that much error has arisen owing to misconception of the nature of the shape of the layer. A. E. G.

199. *Electromagnetic Waves along Wires.* **G. Laville.** (Ann. de Physique, 2. pp. 328–404, Sept.–Oct., 1924.)—The object of the experiments here described is to compare experimental results with the values obtained theoretically for the propagation of electromagnetic waves of high frequency along metallic wires. A line of two parallel wires, limited at its origin by a fixed bridge upon which is inserted a thermoelectric solder, at its end by a mobile bridge, is connected with an oscillator of lamps with 3 electrodes furnishing oscillations of well-defined frequency and constant amplitude. The current which passes in the fixed bridge varies when the mobile bridge is displaced, and by tracing, as function of the displacements of the latter, the curve of the current at the bridge of entry, a curve is obtained of resonance of the line studied for the frequency of the oscillator. This curve enables the damping due to the propagation to be determined by simple graphical operations, and the values so obtained can be compared with those given by the different theories. Frequencies, varying from $1 \cdot 5 \times 10^8$ to 3×10^6 about, are studied. Wires of copper, bronze, and aluminium of differing diameters and placed at different distances are employed and the resonance curve obtained. From the results so obtained the influence of the resistivity of the wires, of their distances, and of their diameters upon the damping of the propagation and upon the diminution of the length of the wave resulting can be determined. By carrying out the same experiments with wires of iron and nickel a study of the influence of hysteresis at high frequencies can be made, as can also a measurement of the magnetic permeability of those metals [see also Abstract 1953 (1923)]. A. E. G.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

200. *The Electrical Conductivity of Rock-Salt Crystals.* **D. v. Seelen.** (Zeits. f. Physik, 29. 2. pp. 125–140, 1924.)—Values for the conductivity have been obtained for temperatures from 20° to over 500° C.; it was found necessary, before taking readings, to heat the crystal above 400°, after which the conductivity at any temperature remained constant. The values obtained agree to some extent with the generally obtained approximate formula for crystal conductivity, $\log k = -A/T + B$, where k is the conductivity, T the absolute temperature, and A and B are constants; the value of A agrees with that found by Joffé for a number of other crystals. The most general explanation of this equation is that the conductivity is proportional to the number of the ions which, owing to thermal molecular motions, pass beyond a certain energy threshold, *i.e.* a certain velocity in the direction of the applied field, the thermal movements thus have a decisive influence on the conduction, which was already evident from the large temperature coefficient. It is difficult to understand how electrolytic conduction can take place in an ideally formed ionic lattice; the results of the author's investigation agree best with the views of Hevesy, who considers that the lattice connections are loosened before conduction can take place. The suggestion of J. Curie, that inclusions of solutions inside the crystal make conduction possible, is negatived by the fact the crystal does not lose in weight when heated all day to 400° C. Measurements with probe electrodes at different parts of the crystal show that no influences which alter the distribution of potential exist at the main electrodes, but that there are space charges in the interior of the crystal. Rock-salt then does not fit into Joffé's classification into crystals with double layers (calc spar) and those with space charges on the electrodes (quartz). Faraday's law has been shown to hold, and the conduction is therefore electrolytic; the Na^+ ion is the only carrier of charge, and Cl^- takes no part in the process. H. N. A.

201. *Hall and Corbino Effects.* **C. Bellia.** (N. Cimento, 1. pp. 159–168, May–June, 1924.)—Drude has postulated in metals two mobile centres, positive and negative. From these Corbino has deduced two fundamental equations $J_x = SX - \epsilon Y$ and $J_y = \epsilon X + SY$. The author has deduced two equations of the same type (differing somewhat from Corbino's in the values of S and ϵ) from a single negative mobile centre. Corollaries developed. A. D.

202. *The Hall Effect of the Photoelectric Primary Current in Non-Conducting Crystals.* **H. Lenz.** (Phys. Zeits. 25. pp. 435–439, Sept. 1, 1924.)—Diamond and zinc blende were used, the crystal being clipped between two electrodes, so that the field passed along its length. The magnetic lines from a large electromagnet, and the light rays producing the photoelectric effect, passed perpendicular to the large surfaces of the crystal plate; a high-voltage battery, earthed in the middle, was connected to the electrodes, and the photo-electric current produced by means of a quartz lamp was measured with a galvanometer. The secondary current could be eliminated by using a voltage which was not too high (about 5000 volts per cm. with ZnS). A knife-edge electrode was placed in contact with each of the smaller sides of the crystal, and could be moved from end to end; these were used to measure the potential drop along the length of the crystal, and also the Hall voltage V_H, which was caused by the bending of the paths of the electrons towards one or other of these side electrodes, in accordance with the direction of the magnetic field. V_H was investigated as depending on H the magnetic field intensity, E the electrical field intensity, and ix the current, and curves are given for both crystals, showing the result of varying one of these quantities while the other two were kept constant. In diamond V_H is exactly proportional to the magnetic field; it is at first proportional to the electric field, but for high values the curve bends over, and V_H reaches a constant maximum value; V_H rises rapidly with the current, and quickly reaches a value beyond which it does not increase when the current is further raised. ZnS crystals are difficult to deal with, and even when they are quite clear and perfect the way they are polished greatly affects the distribution of potential; they do not in general show any true Hall effect, since the deflection does not alter in sign when the magnet field is reversed. If, however, the crystal is cut so that the trigonal axes are symmetrical with respect to the electrical field, the results are somewhat similar to those obtained with diamond. H. N. A.

203. *Electron Theory of Hall Effect.* **L. Page,** with note by **J. A. Eldridge.** (Phys. Rev. 24. pp. 283–286, Sept., 1924.)—In a recent paper [see Abstract 1209 (1923)] Eldridge has given a theory of the Hall effect founded on the assumption that the lengths of the free paths of the electrons in a metal remain unaltered when a magnetic field is applied, and concludes that, accepting his assumption together with the hypothesis that the initial velocities of electrons of the same free path are distributed uniformly in direction, the simple electron theory predicts a zero Hall coefficient in an isotropic conductor. The author finds that the zero effect is due to an error of approximation. Analysis shows that the constant path theory leads to a normal (negative) Hall effect and to a decrease in resistance in both magnetic and electric fields. Patterson's experiments [see Abstract 110 (1903)] show that the resistance is *increased* by a magnetic field, and those of Bridgman [Am. Acad., Proc. 57. p. 131, 1922] on the deviation from Ohm's law at high current-densities show the same effect in the case of an electric field. The theory is therefore as unsuccessful in accounting for resistance changes as in explaining the positive Hall coefficient which exists in the case of many metals. The usual hypothesis that the free times between collisions are unaffected by the presence of a magnetic field is equally unable to explain the positive Hall coefficient and, as van Everdingen has shown [see Abstract 720 (1902)], unless extraneous assumptions are introduced, it leads to a wrong sign for the change of resistance when a conductor is placed in a transverse magnetic field. A simple calculation shows that it leads to a zero second order change in resistance in an electric field.

J. A. Eldridge observes that the error in approximation pointed out by Page merely affects the contributions of electrons moving at oblique angles to the field, but does not affect the main point of his previous paper [see Abstract 1209 (1923)] which is that either a positive or a negative effect may be obtained by varying the velocity distribution amongst the electrons; there is no *a priori* reason for expecting one rather than the other. G. W. DE T.

204. *The Photoelectric Effect with Sub-Microscopic Mercury Spheres.* **E. Wasser.** (Zeits. f. Physik, 27. 4. pp. 203–225, 1924.)—The fact that many substances, especially those which are electropositive, if they are subjected to the action of ultra-violet light when they are in the form of thin plates become positively charged has been long known, and this so-called photoelectric effect has according to Hallwachs a strictly unipolar character. For the investigation of this effect the author has applied the most sensitive method, that of Ehrenhaft's condenser, for the determination of the charge of small test-bodies. (The test-body is denoted by Pk.) It is found (1) that the photoelectric effect with small Hg globules produced by vaporisation in dry gases is dependent upon the magnitude of this Hg-Pk. The upper limit of the inverse photo-effect (giving up of positive charge) is both in N_2 and in CO_2 about $1 \cdot 2 \times 10^{-5}$ cm.; the lower limit of the normal photo-effect (giving up of negative charge) is $1 \cdot 9 \times 10^{-5}$ cm. Within the radius interval $0 \cdot 6$ to $1 \cdot 2 \times 10^{-5}$ cm. the Pk yield only positive electricity, from radius $1 \cdot 9 \times 10^{-5}$ cm. upwards only negative electricity. (2) The general radius interval where both kinds of photo-effect occur, is in both gases about $0 \cdot 7 \times 10^{-5}$ cm. (3) The magnitude of the charge e which the Pk takes up with the Hg lamp appears to be dependent upon the size of the Pk. Thus the amount of the charge is $0 \cdot 6 \times 10^{-10}$ e.s. units, which is about the eighth part of the so-called elementary quantum, much greater than that of the electron itself. (4) The rise of charge appears in the case of the Pk of radius about 2×10^{-5} cm. to be determined by its initial charge. With the larger Pk no such rule of measurement can be established. (5) Smaller rises of charge than about $4 \cdot 4 \times 10^{-10}$ e.s. units up to about half of the electron were proved with larger Pk of radius 3×10^{-5} cm. about, with which the validity of the arrangements for the employment of the Stokes-Cunningham law without question hold good. (6) The sensitiveness of the Hg with ultra-violet light of wave-length 275 $m\mu$ depends on the surrounding gas, on the size of the Pk, on the charge, and on the potential. (7) The ionisation of the gas if it comes about under the influence of the ultra-violet light of wave-length 275 $m\mu$ especially can have no influence on the results. (8) The question whether the photo-effect has its origin at the surface of the Pk in connection with absorbed gas, or comes into existence in the interior of the body itself, can be answered if the same Pk is used with various gas pressures, and its behaviour in relation to the photo-effect is observed. J. J. S.

205. *Photoelectric Thresholds of Elements under Ordinary Conditions.* **R. Hamer.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 251–257, Sept., 1924.)—The apparatus used is fully described with the aid of a diagram, and the photoelectric thresholds for sand-papered commercial samples of fifteen metals and graphite are examined. Light from a carbon arc, sometimes with cored carbons, after dispersion by a mirror mono-chromator with a fluorite prism, is focussed through a fluorite window on the slit of the evacuated photoelectric cell containing a strip of the element being studied connected to a sensitive string electrometer, and the saturation photo-current as a function of wave-length is determined. Scattered light is reduced to a minimum by the use of screens, and the effectiveness of these is tested by introducing filters. This method eliminates many of the usual difficulties. Commercially pure samples are tested with surfaces cleaned by sand papering only. The fairly great intensity of the arc, even to 2600 Å. give reasonably large photo-currents as soon as the threshold wave-length is passed, and enables it to be determined from within ± 30 Å. at 2600 Å. to ± 100 Å. at 3600 Å., corresponding to from ± 0·06 to ± 0·10 equivalent volts, as determined by the formula $V = hV_0/e$. The results in Ångströms for Ag, Al, Bi, C (graphite), Ca, Cd, Cu, Fe, Ni, Pb, Pt, Se, Sn, Th, W, and Zn are respectively: 3390, 3590, 2980, 2615, 4000, 3130, 2665, 2870, 3050, 2980, 2780, 2670, 3180, 3460, 2615, 3420. These results are compared with those of others. This research was undertaken with a view to determining directly the limiting frequencies for the various elementary metals under ordinary conditions. The principle of the method adopted is to use a source giving an approximately continuous spectrum extending over the experimental range of the limiting frequency for an element, and to determine the threshold value by plotting the last values of the diminishing saturation photo-currents against the increasing wave-length of the incident light, or simply to take the average of the various wave-length limits observed in different determinations. No special preparations of the metallic surfaces is made save that of rubbing with sand paper, blowing with dry air, and placing them in the photoelectric cell which is immediately evacuated to a pressure of about 0·006 mm. of mercury. A. E. G.

206. *Photo-Voltaic Phenomena.* **R. Audubert.** (Comptes Rendus, 179. pp. 682–684, Oct. 13, 1924.)—The author has previously shown [see Abstract 1034 (1924)] in experiments upon the action of visible light upon electrodes of pure metals that the polarisation of the lamina exercises a considerable influence upon the intensity and sense of the effect. A polarisation of inverse sign to that which the electrode takes under the action of light increases the photo-voltaic effect, while a polarisation of the same sign diminishes it. But in all cases the effect increases with the polarisation. In the present paper the effect of polarisation upon electrodes of adulterated metals is considered: oxide of copper, bromide of copper, chloride of silver and sulphide of silver. The method is the same as that employed with electrodes of pure metals. These experiments confirm the interpretation relative to pure metals previously given.

A. E. G.

207. *Principles of a Theory of Super-Conductivity.* **E. Kretschmann.** (Ann. d. Physik, 75. 4. p. 448, Oct., 1924.)—The author remarks that the difficulty inherent to his theory of super-conductivity [Abstract 2583 (1924)], *viz.* that the theory of the effect of a magnetic field upon the temperature of incidence of super-conductivity is not in accord with the theory of the Zeeman effect, is to be investigated in a forthcoming paper.

J. S. G. T.

208. *Calculation of Inductance of Coils of Rectangular Cross-Section.* **H. Hemmeter.** (Archiv f. Elektrot. 13. pp. 460–477, Sept. 30, 1924.)—The author deduces a formula, and calculates two tables of constants by means of which the self-inductance of circular coils of rectangular cross-section may be determined with an accuracy of about 0·1 % within the range $b/(2a) = 2$ and $c/(2a) = 1$, where a = mean radius of coil, b = axial width, and c = radial depth [see also Abstract 641 (1922)]. A. H.

209. *Electric Strength, Initial Discharge and Spark Discharge Field Intensities at a Frequency of* 500. **F. Müller.** (Archiv f. Elektrot. 13. pp. 478–506, Sept. 30, 1924.)—The experimental determinations carried out by the author include the following: (1) The electric strength of air, for plane electrodes and spherical electrodes, with both a symmetrical voltage distribution, and with one of the electrodes earthed; (2) the discharge field intensity of a sphere, conducting and non-conducting, when placed in the originally uniform field between two large parallel plane electrodes; (3) the sparking voltage between point electrodes as dependent on their distance apart, and the humidity, temperature, and pressure of the air. As regards (3), the author's intention was to compare his results for a frequency of 500 with those previously obtained by W. Weicker [Abstract 478 (1911)] at a frequency of 50; while (1) and (2) are compared with the values given by A. Klemm [Abstract 1552 (1924)]. In the case of (1) and (2), frequency—up to the limit of 500—seems to produce no effect. As regards (3), certain differences are noticeable, but the author does not regard these as conclusive. A large number of tables and curves is given by the author, showing the results obtained by him, and in most cases the values found by Klemm and Weicker are included for comparison.

A. H.

210. *On the Electric Uses of Squalene Hydrocarbon. The Deleterious Effect of Fibres on Insulation Varnish. The Hardening Effect of Picric Acid on Phenol Resin.* **W. Ogawa, T. Hanyu** and **T. Nishiuchi.** (Electrot. Laborat. Tokyo, Japan, Researches, No. 143. pp. 1–24, April, 1924.)—Squalene hydrocarbon (separated from shark-liver oil and mixed with linseed oil) gives a flash-point of 175° C., viscosity of 100 sec. at 30° C., and breakdown value of 40,000 volts for the standard 0·15-in. gap. It is naturally free from sulphur and other mineral impurities. The dielectric strength of a varnish film contaminated with a small amount of fibre was reduced to one-third or less of that obtained on the pure film free of fibre. The authors point out the necessity of cleanliness in varnish-making. The authors recommend the addition of picric acid as a quick-drying, phenol-resin insulating varnish. The three papers are in Japanese. J. L. L.

211. *Dielectric Constants of Liquid Mixtures.* **M. Grützmacher.** (Zeits. f. Physik, 28. 6. pp. 342–354, 1924.)—The dielectric constants of various organic liquids and mixtures are investigated at different temperatures, and the results are set out in tabular form. For the pure liquids the expressions built on the analogy of those for refractive indices, *viz.* $\frac{K-1}{D}$, $\frac{\sqrt{K}-1}{D}$, $\frac{K-1}{K+2}\cdot\frac{1}{D}$, K being the dielectric constant and D the density, are not constant, but show a variation with temperature. The formula laid down by Silberstein for the dielectric constants of mixtures is not supported by the experiments, this formula being deduced on the assumption that there is no change of volume on mixing. Neither does the formula for refractive index developed by Pulfrich, taking account of volume change, hold when $\sqrt{K}$ is substituted for the refractive index. G. A. S.

212. *Standardisation of an Ampere Meter in High Frequency.* **Clayeux.** (Onde Élec. 3. pp. 513–515, Oct., 1924.)—In a thermic apparatus furnished with a shunt, the splitting up of the current between the two branches is a function of the resistances and inductances of those branches; also very frequently the sensitivity of the ampere-metre varies with the frequency, and standardisation in the high-frequency current is essential. Two simple methods are here given of standardising a high-frequency ampere-metre. The principle of the first is as follows: A lamp with several electrodes is employed. The filament of this lamp is heated successively by a continuous current controlled by a graduated apparatus and by a high-frequency current controlled by the apparatus it is desired to graduate. In the second method the brightness of two identical lamps are compared, one being inserted in a circuit with continuous current and graduated ampere-metre, the other in a high-frequency circuit with the apparatus it is wished to standardise. A. E. G.

213. *Selenium-Cell Density Meter.* **F. C. Toy** and **S. O. Rawling.** (Journ. Sci. Instruments, 1. pp. 362–365, Sept., 1924.)—Two beams of light from opposite sides of an electric lamp, after being diffused by opal screens, pass through suitable optical systems and a specially designed shutter which enables them to fall alternately in quick succession on a selenium cell connected in series with a galvanometer and a source of e.m.f. The density to be measured is placed in the path of one beam, and a standard optical wedge, which can be moved along a scale graduated in density-units, in the path of the other. The wedge is adjusted until the deflection of the galvanometer remains constant. The intensities of the beams falling on the cell are then equal, and the value of the density may be read on the wedge-scale. The instrument is essentially a density comparator, and is calibrated by means of standard densities. A. D.

214. *Push-Pull Valve Oscillator.* **D. C. Prince** and **F. B. Vogdes.** (Inst. Radio. Eng., Proc. 12. pp. 623–650, Oct., 1924.)—The author in a previous paper [see Abstract 403B (1924)] developed methods of calculating the performance of valve oscillators, and showed the increase of efficiency and output obtained when the circuit responds to more than the fundamental frequency. A circuit called the push-pull circuit has been developed in which the two valves are operated 180 degrees out of phase. The idea of these circuits is that each valve should carry current half the time and that the current form should be square in each valve, the summation current being held constant by an inductance in the supply lead. The author has reduced this form of circuit to a calculable design basis. An example is given of a circuit designed for a frequency of 12,000 cycles showing the close agreement between the calculated and observed values. High efficiency is obtained by superimposing upon the grid circuit a voltage proportional to the current variations in the anode circuit. The circuit gives high output combined with high efficiency without shortening the life of the valves. F. S. B.

ALTERNATING CURRENTS AND MAGNETISM.

215. *Magnetism of Oxygen and the Molecule O_4.* **G. N. Lewis.** (Am. Chem. Soc., J. 46. pp. 2027–2032, Sept., 1924.)—One of the most characteristic properties of oxygen is its pronounced paramagnetism; oxygen has, in addition, the chemical properties of a molecule with odd electrons. Curie's law usually holds accurately for the gaseous and liquid forms of a paramagnetic substance, but this does not hold for gaseous and liquid oxygen. It is assumed that the paramagnetism of oxygen is due solely to the O_2 molecule, and that oxygen is a mixture of O_2 and O_4, that O_4 is not paramagnetic, and that unassociated O_2 obeys Curie's law. The thermodynamic consequences of the author's theory are in accordance with the experiments of Perrier and Onnes [Abstract 1142 (1914)]. At the temperature of liquid air, about one-half, by weight, is in the unassociated form, and at ordinary temperature and pressure gaseous oxygen is associated to the extent of only a few hundredths of 1 %. The heat of dissociation is about 128 calories per mol. of O_4, and is responsible for the decrease in the specific heat of oxygen with rise of temperature. G. E. A.

RADIOGRAPHY AND ELECTRO-PHYSIOLOGY.

216. *High Vacua for Thermionic Tubes.* **G. Montefinale.** (Elettrotecnica, 11. pp. 618–621, Sept. 15, 1924.)—The description of the methods employed for obtaining the high vacua required in thermionic tubes is the purpose of this article. In particular the methods adopted in the Royal Italian Navy are indicated. E. B.

217. *Calculation of Thermionic Tubes.* **C. Matteini.** (Elettrotecnica, 11. pp. 621–629, Sept. 15, 1924.)—In this article are indicated the methods adopted in the Royal Italian Navy for calculating thermionic tubes. Besides some known formulæ, results of special experiments, which are reported, are used for the precalculation of tubes. This refers to receiving and generating triodes and to diodes. Practical examples of calculation of a receiving and of generating triode are given at the end of the article. E. B.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

218. *Critical Résumé of Information on Corrosion of Iron and Steel.* **D. V. Onslow.** (British Elect. and Allied Indust. Research Assoc. Comm. No. Z/T. 8. World Power, 2. pp. 146–155, Sept., 1924.)—Consideration of the published literature indicates that no one form of iron will resist all forms of corrosion, it being necessary to take into account the reaction of the medium to which the metal is to be exposed. The behaviour of various forms of iron towards neutral corroding media is no indication of their resistance to attack by acid, and *vice versa.* Iron containing silicon appears to produce the least corrodible alloy, but such iron is very brittle and unworkable and has peculiar properties. Directions are indicated in which further research might usefully be undertaken.

T. H. P.

219. *The Influence of Dilution on Colloids.* **W. Kopaczewski.** (Comptes Rendus, 179. pp. 628–629, Oct. 6, 1924.)—An investigation is made to ascertain if the phenomena shown by blood serum of exhibiting a higher conductivity than is deduced from the law of electrolytic dissociation is exhibited by other salts in presence of colloids. It is found that in physiological liquids generally the presence of colloids prevents the attainment of a limiting value of conductivity on dilution, and gives higher values for the conductivity than in the absence of a colloid.

J. N. P.

220. *Influence of Colloids upon the Kathodic Supertension of Hydrogen and Metals.* **C. Marie** and **G. Lejeune.** (Comptes Rendus, 179. pp. 679–682, Oct. 13, 1924.)—Marie has previously carried out experiments [see Abstract 748 (1909)] in which he showed that the addition of a colloid such as gelatine or gum had a considerable influence upon the supertension of hydrogen. The same experiments indicated that an analogous effect could be established with the metals. In the present paper the research is extended to compare, in particular, upon the same metal the kathodic supertension corresponding to the setting free of hydrogen or to the deposit of the metal itself. The method adopted is the same as that described in the previous paper. The results described show that for Zn, Ni and Pb the energy required to liberate the metal is greater in the presence of colloids than in pure solutions, so that the quantity of metal deposited in a voltameter is smaller than in the absence of colloids. On the other hand, the addition of colloids has no sensible effect in solutions of Cu, Hg, and Ag, and if the modifications produced in the structure and composition of the metal deposited are taken into consideration, all that can be stated is that the energy required for its liberation is slightly increased. The behaviour of copper is discussed at some length.

A. E. G.

221. *Differences between Sols and Gels of Agar.* **E. Hatschek** and **R. H. Humphry.** (Faraday Soc., Trans. 20. pp. 18–22; Disc., 22–29, Aug., 1924.)—Soap sols and gels have, according to McBain, the same electric conductivity. Agar can exist as either sol or gel between 35°

and 95° and has a negligible conductivity of its own. The authors cleared sols of agar, containing up to 7 % of agar and some copper-sulphate, by keeping them at 80° for some hours. The sols and gels differed optically, the gels appearing darker in transmitted light and opalescent in reflected light; the opalescence was not due to segregation of a phase insoluble below the setting point, because it persisted when the gel was kept for days at 62°. In conductivity measurements the gel detached itself from the copper electrode. The sol was therefore filled at 70° to 75° into an inverted U-tube provided below with lateral tubes for the copper-amalgam electrodes. Gels containing electrolytes conduct both d.c. and a.c. better than the corresponding sols, and the difference increases with increasing agar concentration. The conductivity is greater for a.c. than for d.c. The speculative explanation is suggested that, if gelation is the segregation of a phase much richer, and an aqueous phase poorer in agar than the sol, the aqueous phase may carry most of the current and may, notwithstanding the obstruction by the gel phase, owing to its low viscosity offer less resistance than the viscous sol.

In the *Discussion*, **J. H. Shaxby** confirmed the different conductivities of certain electrolytes for d.c. and a.c., while **J. N. Pring** pointed out that the authors' differences were greater than in other cases. The speculative explanation was criticised by **J. W. McBain**, who suggested that sols and gels resembled one another strongly, apart from rigidity and elasticity, and outlined an explanation of the stability of large groups of colloids and their behaviour in solution, coagulation, and gelatinisation, one of the great operative factors being solvation and specific combination; compounds of similar character such as hydrocarbons were mutually soluble. **A. Highfield** referred to nitrocellulose and cellulose acetate solutions in various solvents and to thermally-reversible transitions. **A. W. Porter** pointed out that, scattering being proportional to the square of the refractive index, a small increase in the index would have a conspicuous effect on the scattering. H. B.

222. *Influence of Anions in the Coagulation of a Negative Colloidal Sol.* **D. C. Henry** and **V. A. Morris.** (Faraday Soc., Trans. 20. pp. 30–36; Disc., 36, Aug., 1924.)—In order to determine the stabilising influence of the anion in coagulation by the same kation (gold sol made by Zsigmondy's nucleus method) the authors use a large number of sodium salts and observe the time required for the sol to reach a definite stage of coagulation in the presence of various concentrations of the electrolyte. This stage is determined with the aid of a Dubosc colorimeter. The stabilising influence is found to decrease in the order: oxalate, HPO_4'', CO_3''; citrate, HCO_3', Br', I'; acetate, SO_4'', Cl'; benzoate.

In the *Discussion* the question was raised in how far colour can be considered a criterion of size of particle. H. B.

223. *Velocity of Hydrogen Ions in Gels.* **R. E. Liesegang.** (Zeits. Elektrochem. 30. p. 449, Sept., 1924.)—An explanation of the observation of the inertia of the hydrogen ion by change of voltage based upon diffusion. [See Abstract 1037 (1924).] F. J. B.

224. *The Estimation of Diffusion Potentials.* **P. F. Büchi.** (Zeits. Elektrochem. 30. pp. 443–449, Sept., 1924.)—Two methods are proposed for the investigation of this problem: (1) Using an added electrolyte;

(2) using an intermediate or "bridging" electrolyte. The first method is developed by adopting Debye's formula for the activity coefficient of strong electrolytes in dilute solutions [see Abstract 2171 (1924)], which is shown to give very satisfactory results when applied to the e.m.f. values of concentration cells. The effect of added electrolytes—*e.g.* HNO_3, H_3PO_4, H_2SO_4—to cells of this type is to increase the e.m.f., which is explained by the influence of the interionic forces on the activity coefficient. From a consideration of the influence of the added electrolyte on the distribution of an electrolyte between two immiscible solvents, it is concluded that this method cannot be used for measuring diffusion potentials. A mathematical discussion is given for the relation of the e.m.f. at the phase boundary in this case to the concentration of the electrolytes. It is found with diffusion cells, using HCl and KCl of various strengths as end electrolytes, that the diffusion potential may be eliminated almost entirely, whether the end electrolytes are of equal concentration or equal conductivity, by the use of KCl of sufficient concentrations as a bridging electrolyte. With KCl as intermediate, the diffusion e.m.f. only disappears with end solutions of equal conducting powers. A quantative consideration of these cells shows that the Henderson formula for the e.m.f. developed is much more accurate than that deduced by Planck. B. W. C.

225. *The Diffusion Potentials and Ionic Mobilities of Benzoates and Salicylates and their Modification by a Membrane of Parchment Paper.* **E. B. R. Prideaux** and **W. E. Crooks.** (Faraday Soc., Trans. 20. pp. 37–44, Aug., 1924.)—Measurements previously made showed that the membrane potentials, due to parchment and similar materials, are best treated as modified diffusion potentials [Abstract 2040 (1914)]. In the present paper the measurements are extended to potassium benzoate and salicylate; they indicate that the parchment has a specific effect on the transport number of the slower ion. From conductivity measurements the anionic transport numbers in the following table were deduced :—

Sodium Benzoate.	Potassium Benzoate.	Potassium Salicylate.
$n_A = 0 \cdot 394$	0·307	0·326

The diffusion potentials were measured to obtain independent values of the transport numbers, and the latter were calculated, both neglecting the viscosity and taking it into account, which is generally, though not universally, considered necessary. The resulting transport numbers are as follows :—

	Na Benzoate.	K Benzoate.	K Salicylate.
From the mobilities	0·394	0·307	0·326
From the diffusion potentials	0·392	0·321	0·323
Viscosity considered	0·399	0·313	—

The membrane potentials were determined, using four thicknesses of parchment paper as used in dialysis, held horizontally in vertical tubes; the two sides of the paper were connected with reservoirs, delivering the more concentrated solution just below the membrane and the more dilute just above; the upper and lower surfaces were connected through siphons and taps with the saturated KCl calomel electrodes. The values of the membrane potentials were as follows:—

Na benzoate .... $E_m = 5\cdot34 + 21\cdot14 \log C_1/C_2$
K benzoate .... $E_m = 0\cdot48 + 20\cdot76 \log C_1/C_2$
K salicylate .... $E_m = 0\cdot78 + 30\cdot5 \log C_1/C_2$

C_1 and C_2 are the concentrations of the solution below and above the membrane. From these results a new anion transport number is obtained, $_mn_A$, which should give the relative mobilities of the ions in the membrane:—

	Na Benzoate.	K Benzoate.	K Salicylate.
$_mn_A$	0·3177	0·248	0·242
$_mn_A$	0·81	0·77	0·75

From this it is deduced that the parchment reduces the mobility of the benzoic ion in the ratio 0·735, and that of the salicylic ion in the ratio 0·66.

H. N. A.

226. *Experiment in Solid Diffusion.* **F. C. Thompson and W. H. Dearden.** (Faraday Soc., Trans. 20. pp. 84–85; Disc., 86, Aug., 1924.)—The ratio of diffusion of copper into gold, silver, and a gold-silver alloy consisting of equal proportions of the two metals. A small pellet of each material was hammered into a smaller hole in a separate block of remelted electrolytic copper. The specimens were then annealed for seventy hours a 650° C. *in vacuo* and prepared for examination.

In the case of the alloy, the width of the diffusion band was very clear and of the order of 0·075 mm., but in those of the pure metals it was not so well shown by etching, and heat tinting was utilised to show the band.

The width of the bands were: Silver-gold alloy, 0·075 mm; silver, 0·15 mm.; gold, 0·23 mm.; and it is clear that diffusion takes place much more readily into a pure metal than into a solid solution. It is assumed that added atoms are more readily accommodated in the spaces of the lattice than if they have to replace atoms in the lattice itself.

F. J. B.

227. *A New Aluminium Alloy.* **V. Fuss.** (Zeits. f. Metallkunde, 16. p. 343, Sept., 1924.)—The new alloy "lautal" contains copper and silicon, with not more than 93 % of aluminium, and the amount of iron usually found in commercial aluminium. The treatment of the alloy is a combination of mechanical and heat processes. Breaking strength 38 to 43 kg. per sq. mm. with an extension of 18 to 23 %; this can be raised to 60 kg. per sq. mm. by suitable mechanical treatment, the extension being lowered to 4 %. The elastic limit of the normal alloy (see above) is 30 to 33 kg. per sq. mm.; conductivity roughly 22 to 25 m./ohms-mm.^{2}; Young's modulus 600,000 to 700,000; normal hardness about 92 Brinell units increased by working; specific gravity 2·7 to 2·8. The alloy resists the action of sea-water and other corrosive agents, and is strong at high temperatures. Lautal can be worked with cutting tools, hammered out and drawn. The structure is not altered by age, so that the alloy does not become harder. H. N. A.

228. *Aluminium Solders.* **L. Rostosky.** (Zeits. f. Metallkunde, 16. pp. 359–361, Sept., 1924.)—The prize competition committee of the Deutsche Gesellschaft für Metallkunde having found that several of the specimens submitted satisfied the requirements of a good flux, but were less satisfactory as solders, a second competition is invited. The author considers that the solders should be stable, of low melting-point, and of low specific gravity. As regards the latter, the expensive lithium salts might be replaced by salts of beryllium which, though also expensive so far, occurs in large ore deposits. Solders consisting of seven and more metals have been proposed by the author, but they are not sufficiently studied yet, and cannot yet be produced in the form of wires required for soldering thin foils. H. B.

229. *Electromotive Behaviour of Aluminium.* **A. Smits.** (Zeits. Elektrochem. 30. pp. 423–435, Sept., 1924.)—The paper is a continuation of the subject dealt with in Abstract 999 (1923). The electromotive behaviour of Al, when moved suddenly from a solution of an Al-salt into another solution of the same Al salt and containing also Hg ions, is studied in detail. As noted earlier, the Cl ion exerts an accelerating action and the NO_3 ion a delaying action on the adjustment of the internal equilibrium of the metal. Polished and rough Al electrodes showed different potentials after washing in pure water. From the E-X diagram for Al-Hg electrolyte the action of Hg dissolved in Al was shown to be a catalytic one, and as a consequence the potential of the amalgamated Al must be slightly lower than that of the Al when in internal equilibrium. The electromotive action of Al in solutions of $AlCl_3$ of different concentrations was investigated, and one important factor emerging was that the Al electrode was at no time surrounded by an oxide layer, but always behaves like a metal electrode. The reasons for the production of hydrogen from acid and alkaline solutions are given. The author accepts the view that the metal and liquid boundaries which are in heterogeneous equilibrium contain the same constituents, but in very difficult concentrations, and if the polarisation in the liquid in the neighbourhood of the metal surface increases very much the transition from metal to electrolyte is continuous. He also states that absorption and deposition phenomena, and polarisation in the liquid boundary, are connected. R. S. R.

230. *Negative and Positive Catalysis and the Activation of Molecules.* **N. R. Dhar.** (J. Phys. Chem. 28. pp. 948–961, Sept., 1924.)—The experimental results obtained in connection with a number of oxidation reactions show that the phenomenon of negative catalysis occurs when the catalyst is liable to ready oxidation, and probably intermediate compounds are formed between the catalyst and one or more of the reacting substances. A positive catalyst diminishes and a negative one increases the temperature coefficient of a reaction, the amount of discharge increasing with the concentration of the catalyst. When light acts as an accelerator, the temperature coefficient of a reaction in the light is lower than in the dark. The temperature coefficients of photo-chemical reactions need not be above unity, but is sometimes much greater. Thermal reactions effected in the dark are expected to obey the laws which govern the emission of electrons from heated surfaces, whereas ideal photo-chemical changes should follow the same laws as are applicable to photo-electric emission. The formation of an intermediate compound serves to explain many catalytic accelerations. Potassium permanganate, which is decomposed more readily than the chlorate, is found to be an intermediate stage in the decomposition by heat of potassium chlorate in presence of manganese dioxide or a manganous salt. Absorption of gases by palladium, platinum, charcoal, etc., is accompanied by emission of heat, the assumption that gases are converted into the atomic state by adsorption being hence difficult. It is suggested that active nitrogen, ozone, active hydrogen, active chlorine, etc., are activated by electric discharge or by light, and are charged with a certain voltage, their great activity being due to the ease with which the activated molecules give out this extra energy. Such a theory would suffice to account for the glow of active gases, the phosphorescence caused by light, radium emanation, etc. The slow oxidation of phosphorus, magnesium alkyl halides, organic sulphur compounds, etc., is probably accompanied by the emission of ions and electrons, which could activate the oxygen molecules and thus result in the glow observed. T. H. P.

231. *Investigation on Oppau Ammonium Sulphate-Nitrate.* (Faraday Soc., Trans. 20. pp. 46–83, Aug., 1924.)—The investigation of the ammonium sulphate-nitrate was the outcome of the great explosion at the Badische Anilin und Soda Fabrik at Oppau on September 21, 1921. It consists of several portions, each carried out by special investigators. The introduction is by **R. Threlfall,** and the investigation on the Chemical and Physical Properties of the Oppau Ammonium Sulphate-Nitrate at the Government Laboratory by **R. Robertson.** An Optical Examination of Certain Preparations containing Ammonium Sulphate and Ammonium Nitrate was made by **H. H. Thomas** and **A. F. Hallimond. W. Bragg** conducted the X-ray Examination of the Oppau Salt. In addition to the above a series of reports were furnished by **G. Rotter,** the Director of Explosives Research, Woolwich, as follows: (i) Vacuum stability tests on Oppau salt and ammonium nitrate; (ii) attempts to induce explosion of Oppau salt by the application of a detonative impulse; (iii) attempts to induce explosion of Oppau salt by intense local heating; (iv) experiments with detonative impulse under heavy confinement; (v) examination of samples of astralite and perastralite. The results fail to assign a cause of the Oppau explosion. The chief interest of the inquiry is in regard to the safety of the double salt for use as a fertiliser, and on this point the results are conclusive. For all reasonable quantities the use of the material is perfectly safe. F. J. B.

232. *The Influence of Nitrogen Dilution on the Speed of Flame. Parts I and II.* **C. Campbell** and **O. C. de C. Ellis.** (Chem. Soc., J. 125, pp. 1957–1960, Sept., 1924). **O. C. de C. Ellis** and **S. R. Stubbs.** (*Ibid.* pp. 1960–1963, Sept., 1924.)—The inhibiting influence of nitrogen upon combustion is now so well known as to have become of practical use. Reference is made to previous work by Bunsen, Dixon, Mason and Wheeler [see Abstract 176 (1918)]. Experiments are now described in Part I wherein varying percentages of fuel were burnt with an atmosphere of constant proportions and afforded curves similar in type to those for the uniform movement. An interesting result was obtained, however, when the fuel : oxygen ratio was kept constant and the nitrogen content varied. The factor of mass action being thus cut out, it was possible to study the speed variations due alone to progressive dilutions. For any basic mixture subjected to successive nitrogen dilutions the speed is found to be directly proportional to the calorific value. This law ceases to hold good in the neighbourhood of the limit mixtures, but is true up to and beyond the proportions where the atmosphere is air. The speed-nitrogen curve is an hyperbola of the form $x + xy + ay = k$. Curves are given for methane, ethylene, and carbon disulphide. In the graphs of Part I everything is accounted for except the slight differences of gradient. In Part II the three factors of density, viscosity and specific heat are taken all together under the omnibus title of thermal conductivity. It is now found that when the calorific value is the same for a set of mixtures, the speeds of the mixtures are directly proportional to their thermal conductivity. This conclusion is of high importance in that it provides a simple experimental means for the determination of the thermal conductivity of a gas, whether combustible or inert.

H. H. Ho.

233. *Ignition of Gases. III. Ignition by the Impulsive Electric Discharge. Mixtures of Paraffins with Air.* **R. V. Wheeler and S. C. Lind.** (Chem. Soc., J. 125. pp. 1858–1869, Sept., 1924.)—Having shown [Abstract 223 (1923)] that the general ignitibility of methane-air mixtures by a momentary, intense source of heat is to a considerable degree dependent upon the rapidity with which the flame spreads—*i.e.* on the initial speed of flame propagation—the author describes experiments with other hydrocarbons of the paraffin series. The experiments are carried out in a glass bulb of 75 c.c. capacity, the spark-gap of 1 mm. being formed horizontally between two sharp platinum points in the centre of the sphere. The igniting currents of the order of 1 amp. are measured in the primary circuit of the induction coil. Plotting the amps. against the concentration of hydrocarbon in the air mixture, regular, smooth **U**-curves are obtained, *i.e.* the current required to produce ignition first decreases as the concentration rises and then increases. The ignitibility increases in the order propane, (ethane and butane), pentane, methane, while the maximum speed rises in the order ethane, (propane, butane and pentane), methane, according to Mason; the hydrocarbons bracketed behave similarly. It is striking that methane in this, as in other respects, stands apart from the higher members of the series, and that, whilst with methane the mixture requiring the lowest igniting current contains an excess of air, the other most readily-ignited hydrocarbons contain an excess of hydrocarbon. Tongues of flame are mostly observed before general ignition takes place. The study of gas ignition by electric sparks is thus regarded as a study of flame propagation rather than of flame initiation; there need not be a continued propagation of flame. With respect to the difference between methane and the higher homologues, Lind suggests that the controlling factor is the density of the mixture, as it seems to be in the interaction of hydrogen and oxygen under the influence of α-particles. There an excess of hydrogen (lower density and lower stopping power) lowers the reaction velocity, whilst an excess of oxygen (higher density and stopping power) increases the velocity (Lind, Am. Chem. Soc., J. 41. p. 592, 1919). Further (Dixon and Crofts), the ignition temperature of H-O mixtures is lowered by an excess of oxygen and raised by an excess of hydrogen. The α-ray experiments show that the constituent in excess does not act merely as a diluent. The ionisation of α-particles would be practically the same for oxygen as for methane (1·09 and 1·10), but the stopping power for α-rays differ—1·064 for oxygen and 0·86 for methane. H. B.

234. *Ignition of Gases. IV. Ignition by a Heated Surface. Paraffin-Air Mixtures.* **W. Mason** and **R. V. Wheeler.** (Chem. Soc., J. 125. pp. 1869–1875, Sept., 1924.)—In these experiments cylinders of quartz, 85 c.c. capacity, are evacuated, heated and quickly charged with the gas mixture. The lowest ignition temperature is determined by lowering the wall temperature in steps of 5° and finally of 1°. As the limit was reached, the ignition lag increased from a few seconds to two minutes sometimes. The i.t. increased in the order: pentane (below 500°), butane, propane, ethane (about 550°), methane (700°). Lind's suggestion is accepted. The stopping power for RaC are (Bragg): oxygen 1·067, methane 0·86, ethane 1·519, pentane 3·544. In another series of experiments the cylinder was kept at 600° and the i.t. were determined for different percentages of the hydrocarbons (methane excluded). At higher temperature the time lags are very short, and they would be so in spark experiments. H. B.

235. *Coal-Dust Explosions at the Mines Department Experimental Station at Eskmeals.* **H. B. Dixon.** (Manchester Phil. Soc., Mem. 68. pp. 1–14, 1923–1924.)—A description of recent progress in the investigation of the properties of gases is first given. A development of the author's concentric tube method for determining the ignition-points has enabled clear differentiation between instantaneous ignition and ignition after a time interval to be established, hydrogen igniting instantaneously at 631°, and 565° after a lag of 20 seconds. The ignition-point of gases at high pressures is determined by measuring the compression necessary to fire an explosive gas mixture. The specific heats of gases at high pressures have been determined very accurately by measurement of the velocity of sound in the gases. A review is given of work leading to the establishment of the Eskmeals station, including the Altoft experiments, which showed that coal-dust could develop an explosion. The early history of the Eskmeals station and the relation of the results obtained there to the work of F. Abel is described and discussed, leading to the conclusion that the presence of inert dusts tends to diminish the risk of gas explosions. A coal-dust cloud can be ignited and propagate a flame, provided it exists before the flame reaches it. Experimental methods of producing the clouds are described. The effect of resistance to the air waves, such as pit props, etc., is greatly to increase the rapidity and pressure of the flames. It is observed that a gun fired near the closed end of the gallery fails to ignite the cloud raised by the concussion, but will cause propagation of flame if moved 50 ft. from the closed end. The theoretical basis of this is discussed. Experiments show that a mixture of equal parts of inert dust—*e.g.* shale or fullers earth—and coal-dust may propagate an explosion if there is a sufficiently intense explosion flame to start it—*e.g.* pure coal-dust—but the mixture is difficult to ignite without this preliminary priming; 24 ozs. of blasting-powder failed to explode this 1 : 1 mixture in a 3-ft. tube, even with over 4 % methane in the air, but experiments with finely ground coal from certain seams show that such a mixture may be ignited by a similar charge, the risk of explosion being greatly diminished by the use of modern short-flame explosives. B. W. C.

236. *The Rate of Dissociation of the Bromine Molecule.* **M. Bodenstein.** (Zeits. Elektrochem. 30. pp. 416–417, Sept., 1924. Paper read before the Deut. Bunsen. Gesell., Göttingen, 1924.)—A consideration of the sequence of events which leads to the formation of hydrogen bromide from the elements gives a series of reactions, whose equilibrium constants will determine the rapidity of the process. In the presence of iodine, the reaction $H + Br_2 = H . Br + Br$, which regenerates bromine atoms, is partially superseded by the reaction $H + I_2 = HI + I$, and therefore the process is governed by this action in conjunction with the dissociation $Br_2 = 2Br$ (constant k_1). From this the equation for the reaction is developed, *viz.*

$$k_1 = \frac{\frac{d[HBr]}{dt}}{4[Br_2]} \cdot \frac{I_2}{[Br_2I_2 + I_2]}$$

i.e. from the observed rate of formation of hydrogen bromide the rate of dissociation of the bromine molecule may be calculated. The value thus obtained at 300° C. and 1 atmosphere pressure is only 1/120th of the directly observed figures, and it is suggested that further research should be carried out in this matter.

The progress of the reaction $Br + Br = Br_2$ may be studied by comparison of the rule of formation of hydrogen bromide with definite quanta of light with the rate in darkness, and this leads to a result comparable with that quoted above. Photo-chemical investigations are in progress which it is hoped will solve the problem. B. W. C.

237. *The Composition and Properties of Clay.* **A. F. Joseph** and **J. S. Hancock.** (Chem. Soc., J. 125. pp. 1888–1895, Sept., 1924.)—Gives the composition of a number of clays together with some physical and chemical properties which appear correlated with composition. Investigations on the relationship between composition and properties of clays must be made with homogeneous preparations, the coarser portions being rejected. The ultimate analysis of a number of clay separates showed wide differences in compositions, especially as regards the silica-alumina ratio. This ratio seems connected with essential "clay" properties, being low in non-plastic and high in plastic materials. It is suggested that a property (such as the moisture equivalent) which is greatly modified by ignition and electrolytes might afford a measure of plasticity for practical purposes: the silica-alumina ratio appears connected with these modifications. The same constant seems related to the chemical reactivity shown by different clays towards sodium hydroxide and neutral electrolytes; in the latter case the development of acidity is regarded as a special case of base exchange. C. O. B.

238. *Influence of Neutral Salts on the Potential Difference between Hydrochloric Acid and the Hydrogen Electrode.* **L. Michaelis** and **M. Mizutani.** (Zeits. phys. Chem. 112. pp. 68–82, Sept. 6, 1924.)—The research is a contribution to the study of Bjerrum's activity factor, and concerns the changes in the potential of highly diluted aqueous solutions of HCl (0·002N) by the addition of neutral salts, single or in mixtures. The effect of the ions seems to vary with their atomic weights. As the concentration of the salt is raised, the effect first increases a little to a maximum near concentration 0·3N, and then decreases decidedly, being first positive and then negative. In the case of the chlorides the effect increases in the order Li (which in low concentrations has no appreciable effect), Mg, Na, Ca, Ba, K, Rb, so that finally LiCl lowers the potential most and RbCl least. In the case of sodium salts the order is $NaNO_3$, NaBr, NaCl. When mixtures of two salts are used the effect is additive in a peculiar way. Thus with($NaCl + CaCl_2$) the total effect is smaller, and the mixture-curve is almost a horizontal line; the effect of the mixture of a total salt concentration of 1·4N is independent of the ratio of the constituents. The potentiometer arrangement used is that of Michaelis and Gyemant (Biochem. Zeits. 109. 165, 1920). H. B.

239. *Electro-chemical Behaviour of Hydrazine. A New Electro-capillary Effect.* **S. Bodforss.** (Arkiv. f. Kem. Min. o. Geologie, Stockholm, 9. 5. pp. 1–32, 1924.)—Experimenting on the preparation of hydrazine amalgam, the author divided a glass beaker into two halves by a vertical glass plate not reaching quite down to the bottom. Each half contained mercury, and an aqueous solution of hydrazine sulphate was poured into the anode compartment, in which was inserted the rotating platinum anode; the kathode wire was fused into the other compartment. Under an e.m.f. of about 5 volts the solution travelled over into the kathode compartment, forcing its way down between the mercury and the glass and forming gas bubbles at the bottom of the mercury, which were observed through a mirror to rise. The phenomenon dependent upon the formation and decomposition of an amalgam does not appear to be directly chemical, but seems to be connected with ionic polarisation. The author suggests an electric double-layer effect. The hydrazine solution must be alkaline; many other amines give the same result. H. B.

240. *The Wandering of Ions in Solid Electrolytes.* **G. C. Schmidt.** (Zeits. Elektrochem. 30. pp. 440–443, Sept., 1924.)—In Abstracts 627 (1924) and 98 (1925) the author has described experiments in which various salts are heated on a platinum wire, surrounded by an isolated wire gauze cylinder connected with an electrometer; the wire was charged, and it was found that with some salts positive and with others negative charges were given off. Determinations of *e/m* showed that silver salts gave out the ions Ag^+, while bivalent elements gave out ions with a double charge in such as Cd^{++}, Zn^{++}, Cu^{++}, Ca^{++}. These ions are given off even with zero voltage, and must exist in the salt as such, so that conduction in the salt at the temperature in question must be electrolytic; the same is true when negative ions are given off. Substances which at a certain temperature give off electrons conduct metallically at this temperature. To explain why in the majority of cases only + ions are emitted, the author assumes that complex molecules are formed, such as Cd_4I_8, which split up into Cd^+ and $Cd_3I_8^-$. The mobility of the second ion is small, and practically only the Cd^+ ion moves in the electric field. It is pointed out that nothing is known of the lattice structure of the salts experimented with at high temperatures, though the author is of opinion that the structure is broken up. H. N. A.

241. *Electrolytic Separation of Copper, of Antimony, and of Bismuth from Lead.* **A. Lassieur.** (Comptes Rendus, 179. pp. 632–634, Oct. 6, 1924.)—Use is made of a system of graded potentials, as described in an earlier publication [Abstract 1047 (1924)], the p.d. between the kathode and the electrolyte being measured by an auxiliary mercury electrode. The separation of lead, together with copper, antimony, and bismuth, is effected from an electrolyte containing hydrochloric acid in presence of a reducing agent, of which the most suitable appears to be hydroxylamine hydrochloride. A temperature of 50°–60° C. is employed and an auxiliary potential of 440 millivolts. A portion of the hydrochloric acid can be replaced advantageously by nitric or hydrofluoric acid. Bismuth, copper, and antimony are separated from lead at potentials of 200 to 240 milivolts under conditions similar to the above, which are detailed. J. N. P.

242. *Cataphoresis of Gas Bubbles in Water.* **T. Alty.** (Roy. Soc., Proc. 106. pp. 315–340, Sept. 1, 1924.)—The results of numerous measurements show that the velocity of a gas bubble in water exposed to an electric field is independent of the character of the gas, but varies widely with the diameter of the bubble, the maximum velocity being $4{\cdot}1 \times 10^{-4}$ cm. per sec. per volt per cm. for the diameter about 0·1 mm. The velocity is proportional to the strength of the field applied throughout the whole range of bubble-diameters. Some little time elapses after introduction of the bubble into the water before it acquires its full charge. The bubble attains its highest velocity only in water of specific conductivity $6{\cdot}5 \times 10^{-6}$ ohm^{-1}, and when the value is $1{\cdot}8 \times 10^{-6}$ ohm^{-1} the charge on the bubble is very small and is occasionally reversed during the course of an experiment. The rate at which a bubble is absorbed by the water exerts a marked influence on the velocity, and two bubbles appear to repel one another.

These results are not in accord with the mathematical theory of the double layer as worked out by Lamb and Helmholtz, which indicates that the velocity of the bubble should be independent of its size. They agree, however, moderately well with Mukherjee's suggestion that the double layer is a direct result of the selective adsorption by the particle of ions of one sign. T. H. P.